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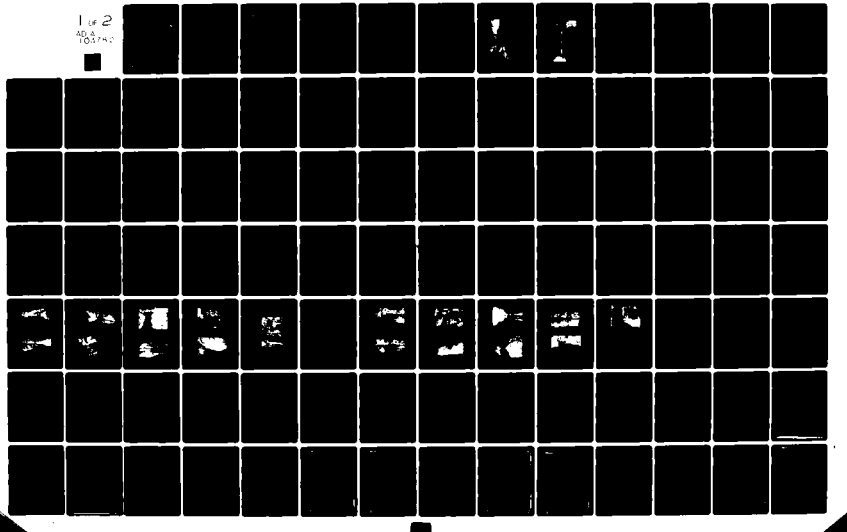

LEVEL II

4 MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

AD A104782

3 CEDAR HILL LAKE NO. 2 AND NO. 3 DAMS

5 JEFFERSON COUNTY, MISSOURI

3 MO 30005 AND MO 31020

6 # PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JANUARY 1979

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REPORT DOCUMENTATION PAGE

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Cedar Hill Lake No. 2 and No. 3 Dams (Mo. 30005 and 31020), Phase I Inspection Report

This report presents the results of field inspection and evaluation of Cedar Hill No. 2 and No. 3 Dams (Mo. 30005 and 31020). It was prepared under the National Program of Inspection of Non-Federal Dams.

SIGNED

SUBMITTED BY: _____ 20 FEB 1979
Chief, Engineering Division (Date)

APPROVED BY: _____ FEB 1979
Colonel, CE, District Engineer (Date)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Cedar Hill Lake No. 2 and No. 3 Dams Missouri Inv. No. 30005 and 31020
State Located:	Missouri
County Located:	Jefferson
Stream:	Unnamed Tributaries of Big River
Date of Inspection:	October 3, 1978

Assessment of General Condition

Cedar Hill Lake No. 2 and No. 3 Dams were inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dams are in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam.

The estimated damage zone for Cedar Hill Lake No. 2 Dam extends two miles downstream of the dam. Within the first mile downstream of the dam are five to six houses, two improved road crossings, and State Highway 30 crossing.

The estimated damage zone for Cedar Hill Lake No. 3 Dam also extends two miles downstream of the dam. Within the first mile downstream of the dam are six houses, one of which is located immediately downstream of the toe of the dam, and one improved road crossing at County Road B crossing.

Both dams are in the small size classification since they are less than 40 feet high and impound less than 1,000 acre-feet of water.

Our inspection and evaluation indicates that the spillway of Cedar Hill Lake No. 2 and No. 3 Dams meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. These dams are small size dams with a high hazard potential required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping. Considering the small volume of water impounded, and the large floodplain downstream, one-half of the PMF is the appropriate Spillway Design Flood (SDF). It was determined that the spillways will pass 55 percent of the Probable Maximum Flood without overtopping the dam. Our evaluation indicates that the spillways will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Other deficiencies noted by the inspection team were a need for a periodic inspection by an experienced engineer in design and construction of dams; lack of a maintenance schedule; extensive brush and tree growth on the embankment; vegetative growth in the

spillway channels; embankment sloughing on the upstream slope of dam No. 3; a need for reconstruction of the spillway discharge channel for dam No. 3; and a need for an engineering study for the section between dams No. 2 and No. 3. The lack of stability and seepage analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.

CEDAR HILL LAKE NO. 2 DAM

CEDAR BELL LAKE NO. 3 DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Cedar Hill Lake No. 2 and No. 3 Dams, I.D. No. 30005 and 31020

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CEDAR HILL LAKE NO. 2 NO. 3 DAMS,
Missouri Inv. No. 30005 and 31020

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for the Cedar Hill Lake No. 2 and No. 3 Dams was carried out under Contract DACW 43-78-C-0160 to the Department of the Army, St. Louis District, Corps of Engineers, by the engineering firms of Consoer, Townsend & Associates Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of the Cedar Hill Lake No. 2 and No. 3 Dams was made on October 3, 1978. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dams with respect to safety.

It should be noted that reference in this report to left or right abutments is as viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to west abutment or side, and right to the east abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D. These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of the Project

Cedar Hill Lake No. 2 Dam

a. Description of Dam and Appurtenances

It should be noted that design drawings are not available for the dam or appurtenant structures. The following description is based exclusively on observations and measurements made during the visual inspection.

The dam embankment is likely a homogeneous earthfill structure. The crest of the embankment has a typical width of 20 feet and a length of approximately 500 feet. The crest elevation is set at 545.0 feet above MSL, and the maximum height of the embankment is 38 feet above the minimum streambed elevation along the centerline of the dam. The embankment slopes for the typical section is 1V to 2H upstream and 1V to 2-1/2H downstream.

Bedrock at the site and within the vicinity is composed of Ordovician age silty and chert dolomite. A residual clay, a weathered product of the bedrock, commonly mantles the rolling hills. Alluvial deposits are encountered along the stream courses of the area.

Natural outcroppings of the bedrock are not found over the site. Excavations for the spillway and its discharge channel, along the ridge slopes on the west side of the dam, and for a channel traversing the ridge between Lakes No. 2 and No. 3, expose bedrock. The bedrock exposed is a hard, thin, horizontally bedded dolomite.

Data is not available to provide a description of the foundation conditions, or preparation, previous to placement of the embankment. It is expected that the abutments are founded in dolomite and that the base of the embankment is placed on alluvial deposits or residual soil.

The spillway for Cedar Hill Lake No. 2 Dam is at a natural depression in the west abutment, just beyond the dam embankment. Overflow from the reservoir is uncontrolled. A 20-inch thick concrete weir is constructed at the entrance from the reservoir. The spillway channel is excavated in rock and exits through a series of rock falls before entering the natural channel. A sketch showing the relative elevations is given as a Plate in this report.

There is no operating outlet pipe or low level drain at the damsite.

Cedar Hill Lake No. 2 impounds approximately 198 acre-feet of water from a drainage area of 0.42 square miles. Cedar Hill Lake No. 2 is connected with Cedar Hill Lake No. 3 by a 15-foot wide, 6-foot deep and 150-foot long connecting channel.

Pertinent physical data are given in Paragraph 1.3 below.

b. Location

Cedar Hill Lake No. 2 Dam is located on an unnamed tributary of the Big River, Jefferson County, Missouri. Cedar Hill Lake No. 2 Dam is linked with Cedar Hill Lake No. 3 Dam by a connecting channel. The nearest community downstream of the dam is the town of Cedar Hill, which is about

1-1/2 miles from the dam. The dams and reservoir are shown on the Cedar Hill Quadrangle Sheet (7.5 minute series) in Section 35, Township 42 North, Range 3 East.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" in dam height category because its height is less than 40 feet. The overall size classification is, accordingly, "Small" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends two miles downstream of the dam. Within the first mile downstream of the dam are five to six houses, two improved road crossings, and State Highway 30 crossing.

e. Ownership

Cedar Hill Lake No. 2 Dam is owned by Property Owners Corporation, a group of home owners who live around the perimeter of the Cedar Hill Lakes. The mailing address is Property Owners Corporation, c/o Duke Beckerman, P.O. Box 34A, Route 2, Cedar Hill, Missouri 63016.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

Cedar Hill Lake No. 2 Dam was originally designed and constructed in 1949 by Walter Ficken, a private developer. No design plans or specifications were used at the time of construction.

h. Normal Operational Procedures

The dam at Cedar Hill Lake No. 2 is used to impound water for recreational use. There are no facilities other than the spillway to control water level in the lake. Water level below the spillway is controlled by rainfall, runoff, and evaporation.

Cedar Hill Lake No. 3 Dam

a. Description of Dam and Appurtenances

It should be noted that design drawings are not available for the dam or appurtenant structures. The following description is based exclusively on observations and measurements made during the visual inspection.

The dam embankment is likely a homogeneous earth-fill structure. The crest of the embankment has a width of 17 feet and a length of approximately 310 feet. The crest elevation is set at 545.0 feet above MSL, and the maximum height of the embankment is 39 feet above the minimum stream-bed elevation along the centerline of the dam. The embankment section is constructed with 1V to 1-1/2H upstream slope, and 1V to 2H downstream slope.

Bedrock at the site and within the vicinity is composed of Ordovician age silty and cherty dolomite. A residual clay, a weathered product of the bedrock, commonly mantles the rolling hills. Alluvial deposits are encountered along the stream courses of the area.

Natural outcroppings of the bedrock are not found over the site. The excavation for a channel traversing the ridge that separates Dams No. 2 and No. 3, exposes bedrock. The bedrock found here was a hard, thinly and horizontally bedded dolomite.

Data is not available to provide a description of the foundation conditions, or preparation, previous to placement of the embankment. It is expected that the abutments are founded in dolomite and that the base of the embankment is placed on alluvial deposits or residual clays. The spillway and its discharge channel, located to the south of the embankment, are apparently founded on natural terrain.

The spillway for Cedar Hill Lake No. 3 Dam is an uncontrolled section on a natural depression which is located in the east abutment just beyond the dam embankment. The spillway crest is a triangular shaped, grass lined open channel, which has a top width of 20 feet. The spillway is

running in a northerly direction, and exits directly into the floodplain at approximately 80 feet downstream from the toe of the embankment. A sketch showing the relative elevations of both Cedar Hill Lake No. 2 Dam and Cedar Hill Lake No. 3 Dam is given as a Plate in this report.

There is no operating outlet pipe at the dam.

Cedar Hill Lake No. 3 impounds approximately 60 acre-feet of water from a drainage area of 0.06 square miles. Cedar Hill Lake No. 3 is connected with Cedar Hill Lake No. 2 by a 15-foot wide, 6-foot deep, and 150-foot long connecting channel.

Pertinent physical data is given in Paragraph 1.3, below.

b. Location

Cedar Hill Lake No. 3 Dam is located directly to the east of Cedar Hill Lake No. 2 Dam, which is on an unnamed tributary of the Big River, Jefferson County, Missouri. Cedar Hill Lake No. 3 and Cedar Hill Lake No. 2 are linked by a connecting channel. The nearest community downstream is the town of Cedar Hill, which is about 1-1/2 miles from the dam. The dam and reservoir are shown on the Cedar Hill Quadrangle Sheet (7.5 minute series) in Section 35, Township 42 North, Range 3 East.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" in dam height category because its height is less than 40 feet. The overall size classification is, accordingly, "Small" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends two miles downstream of the dam. Within the first mile downstream of the dam are six houses, one of which is located immediately downstream of the toe of the dam, and one improved road crossing at County Road B crossing.

e. Ownership

Cedar Hill Lake No. 3 Dam is owned by Property Owners Corporation, a group of home owners who live around the perimeter of the Cedar Hill Lakes. The mailing address is Property Owners Corporation, c/o Duke Beckerman, P.O. Box 34A, Route 2, Cedar Hill, Missour 63106.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

Cedar Hill Lake No. 3 Dam was originally designed and constructed in 1949 by Walter Ficken, a private developer. No design plans or specifications were used at the time of construction.

h. Normal Operational Procedures

The dam is used to impound water for recreational use. There are no facilities other than the spillway to control water level in the lake. Water level below the spillway is controlled by rainfall, runoff, and evaporation.

1.3 Pertinent Data

Cedar Hill Lake No. 2 Dam

a. Drainage Area (acres):	270
b. Discharge at Damsite	
Estimated experienced maximum flood (cfs):	720
Estimated ungated spillway capacity at maximum pool elevation (cfs):	1,720
c. Elevation (Feet above MSL)	
Top of dam:	545.0
Spillway crest:	540.0

Minimum streambed elevation at centerline of dam:	507.0
Maximum tailwater:	Unknown

d. Reservoir

Length of maximum pool (feet):	2,000

e. Storage (Acre-Feet)

Top of dam:	273
Spillway crest:	198

f. Reservoir Surface (Acres)

Top of dam:	18
Spillway crest:	12

g. Dam

Type:	Rolled Earthfill
Length:	500 feet
Height (maximum):	38 feet
Top width:	20 feet
Side slopes:	
Downstream	1V to 2-1/2H
Upstream	1V to 2H
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	Unknown
Grout curtain:	Unknown

h. Diversion and Regulating Tunnel None

i. Spillway

Type:	Uncontrolled
Length of weir:	36 feet
Crest Elevation:	540 feet (MSL)

j. Regulating Outlets — None

Cedar Hill Lake No. 3 Dam

a. Drainage Area (acres): 36

b. Discharge at Damsite

Estimated experienced maximum flood (cfs):	5
Estimated ungated spillway capacity at maximum pool elevation (cfs):	41

c. Elevation (feet above MSL)

Top of dam:	545.0
Spillway crest:	543.5
Minimum streambed elevation at centerline of dam:	506.0
Maximum tailwater:	Unknown

d. Reservoir

Length of maximum pool (feet):	600

e. Storage (acre-feet)

Top of dam:	65
Spillway crest:	60

f. Reservoir Surface (acres)

Top of dam:	4
Spillway crest:	3

g. Dam

Type:	Rolled Earthfill
Length:	310 feet
Height (maximum):	39.0 feet
Top width:	17 feet

Side slopes:	
Downstream	1V to 2H
Upstream	1V to 1-1/2H
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	Unknown
Grout curtain:	Unknown

h. Diversion and Regulating Tunnel — None

i. Spillway

Type:	Uncontrolled
Length of weir:	V-shaped channel with top width of 20 feet
Crest Elevation:	543.5 feet (MSL)

j. Regulating Outlets — None

SECTION 2: ENGINEERING DATA

2.1 Design

Design drawings are not available for the dam or appurtenant structures. The dam was designed and constructed in 1949 by Walter Ficken.

2.2 Construction

No construction data is available for the dam and appurtenant structures.

2.3 Operation

No operation data is available for Cedar Hill Lake No. 2 Dam.

2.4 Evaluation

a. Availability

No design drawings, design computations, construction data or operation data is available.

In addition, no pertinent data was available for review of hydrology spillway capacity, flood routing through the reservoir, outlet capacity, slope stability, seepage analysis, or foundation conditions.

b. Adequacy

The available engineering data is inadequate to aid in evaluating the hydraulic and hydrologic capabilities and stability of the dam for Phase I investigations.

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection, past performance history, and sound engineering judgment.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data is available.

SECTION 3: VISUAL INSPECTION

Cedar Hill Lake No. 2 Dam

3.1 Findings

a. General

A visual inspection of Cedar Hill Lake No. 2 Dam was made on October 3, 1978. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Yin Au-Yeung	Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
David Bramwell	Engineering Consultants, Inc.	Geology
Jon Diebel	Engineering Consultants, Inc.	Soils
John Ismert	Engineering Consultants, Inc.	Mechanical
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil & Structural

Specific observations are discussed below.

b. Dam

The crest of the dam embankment has a light vegetative cover. The appearance of the crest indicates that minimal travel occurs on the crest.

The upstream slope of the embankment is provided with a thin layer of rock riprap. The riprap is composed of limestone blocks to a maximum size of 2 feet in diameter. This riprap is very uneven, with some areas having a thick layer, and others having no riprap at all. The slope where riprap is not present is generally well vegetated, but minor sloughing of embankment materials is occurring near the high water elevation. Some small trees are beginning to grow on the upstream slope.

The downstream embankment slope is overgrown with trees and large brush. One section of embankment 30-feet wide had been cleared from the crest to a point approximately 100 feet downstream of the toe of the dam. Conversation with the maintenance superintendent indicated the slope was cleared following observation of seepage in this area. A line of piezometers along the toe of the dam had been installed to provide information concerning the phreatic line in the embankment section. There are a total of 10 standpipe piezometers in a line at the downstream toe of the dam beginning at the right abutment of the dam and extending to the center of the dam. All of the piezometers, except the one located furthest north, was filled with concrete. The water level in this piezometer was 5 feet below the ground surface.

Seepage was not observed on the cleared area. However, a seepage area 30-feet long by 3 to 5 feet wide was seen 5 feet beyond the embankment toe downstream of the right abutment of Dam No. 2. This area was moist and boggy, with phreatophytes growing. No other seepage was observed on the embankment or in the foundation, however, some vegetation, normally indicating the presence of seepage, was observed at the center and toward the left side of the dam. Some ponding water was located in the spillway discharge channel, but it is

thought to be from local drainage. The moist areas are shown on Plate 1.

No signs of past or present instability was seen on the embankment or in the foundation at any location with the exception of the sloughing discussed above.

c. Appurtenant Structures

(1) Spillway

The uncontrolled spillway is cut through a natural depression on the left abutment. The concrete weir at the entrance of the spillway was in a deteriorated condition. Brush is growing in the vicinity of the spillway approach channel. The original wire fence on top of the concrete crest was missing. A small concrete cap was placed on the first 50 feet length of the rock spillway channel to prevent erosion. The concrete cap shows signs of deterioration. The uncontrolled spillway at Cedar Hill Lake No. 2 Dam and the uncontrolled spillway at Cedar Hill Lake No. 3 Dam combine to control the reservoir pool levels.

(2) Outlet Works

No outlet works or reservoir drain are provided for the dam and reservoir.

d. Reservoir Area

The reservoir rim is stable with private homes located around the perimeter. No signs of excessive erosion nor slope slumping were present. The reservoir is linked with Cedar Hill Lake No. 3 reservoir by a connecting channel which is a 6-foot deep, 15-foot wide, rectangular section cut in rock.

e. Downstream Channel

The rock drop at the end of the spillway channel is in good condition. The original streambed channel is well defined and also in good condition.

3.2 Evaluation

The following items were observed which could affect the safety of the dam, or which will require maintenance within a reasonable period of time.

1. The seepage area observed on the downstream embankment slope near the right abutment of the dam.

2. The tree growth prevalent on the downstream embankment slope.

3. The vegetation in the spillway channel.

Cedar Hill Lake No. 3 Dam

3.1 Findings

a. General

A visual inspection of Cedar Hill Lake No. 3 Dam was made on October 3, 1978. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Yin Au-Yeung	Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
David Bramwell	Engineering Consultants, Inc.	Geology
Jon Diebel	Engineering Consultants, Inc.	Soils
John Ismert	Engineering Consultants, Inc.	Mechanical
Keven Blume	Consoer, Townsend & Assoc., Ltd.	Civil & Structural

Specific observations are discussed below.

b. Dam

The crest of the embankment is protected with a heavy vegetative cover. Vehicular traffic on the dam crest appears to be very minimal.

The upstream slope of the embankment exhibits substantial sloughing above the normal water surface elevation. The slope is nearly vertical in some locations due to sloughing. The slope is not protected by riprap, and the vegetative cover, although heavy, does not appear to be adequate to protect a slope as steep as 1V to 1-1/2H.

The downstream embankment slope is overgrown with trees and large brush. This heavy vegetation made proper inspection of the slope virtually impossible. One stump observed on the slope was 2 feet in diameter.

No signs of past or present instability were seen on the embankment or in the foundation at any location. Also, no seepage was observed on the downstream slope or downstream of the toe.

c. Appurtenant Structures

(1) Spillway

The spillway crest area is well maintained. However, the spillway discharge channel is unlined, and is filled with debris and trees. There is no defined exit channel downstream from the spillway discharge channel. A private home is located less than 20 feet from the spillway exit. A large discharge through the spillway would likely flood this house. The uncontrolled spillways at Cedar Hill Lake No. 3 Dam and Cedar Hill Lake No. 2 Dam combine to control the reservoir pool levels between the spillway crest of Cedar Hill Lake No. 2 Dam and the top of the embankment.

(2) Outlet Works

No outlet works or reservoir drain are provided for the dam and reservoir.

d. Reservoir Area

The reservoir rim is surrounded by private homes. The slopes of both banks of the reservoir are relatively steep. However, the shoreline is well kept and adequately maintained by the local property owners, and no sign of excessive erosion or slope instability were observed.

e. Downstream Channel

By usual definition, there is no downstream channel. Flow through the spillway channel exits directly onto the floodplain and follows along the natural terrain, then finally drains into the Big River.

3.2 Evaluation

The following items were observed which could affect the safety of the dam, or which will require maintenance within a reasonable period of time.

1. Large brush and tree growth prevalent on the downstream embankment slope.

2. Sloughing and erosion of embankment materials on the upstream slope of the dam.

3. The trees and debris in the spillway channel.

4. The lack of a defined exit channel downstream of the spillway, and past the private home near the spillway exit.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Cedar Hill Lakes No. 2 and No. 3 are used solely for recreational purposes. At the time of its construction, no provisions were made for drawing down the reservoirs, and in their present condition, there is no facility available at the damsites for regulating the water level.

4.2 Maintenance of Dam

Cedar Hill Lake No. 2 Dam

The dam is maintained by the manager of Property Owners Corporation, with corrective measures being performed as they are needed. In the spring of 1977, seepage was discovered on the east downstream toe, and a local consultant was hired to determine the water level at several points along the downstream toe. An area near the seepage was cleared of brush and trees, and the piezometers were installed to investigate water levels. Further details are not available, since we were unable to contact the company that initially studied the seepage problem.

Additional items which require maintenance include clearing of trees from the downstream and upstream slopes, and clearing the spillway approach channel of vegetation.

Cedar Hill Lake No. 3 Dam

The dam is also maintained by the manager of Property Owners Corporation, with corrective measures being performed on an as-needed basis. The following maintenance items should be implemented to ensure to dam's structural integrity and operational adequacy: 1) Clean the downstream and upstream embankment slopes of all trees and large brush, and 2) Control the embankment sloughing on the upstream slope of the dam. These corrective measures should be undertaken within a reasonable amount of time.

4.3 Maintenance of Operating Facilities

As mentioned in Paragraph 4.1, there are no facilities at the damsite which require maintenance. No water level records are kept for these two lakes.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system in effect.

4.5 Evaluation

The operation and maintenance for this dam, with the exception of those items mentioned in Paragraph 4.2, seems to be satisfactory. Very little operation is required for the lakes, however, the maintenance items listed in Paragraph 4.2 should receive attention within a reasonable length of time.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

Cedar Hill Lake No. 2 Dam has a watershed of approximately 270 acres, and Cedar Hill Lake No. 3 Dam has a watershed of approximately 36 acres. Land gradients in the two watersheds average roughly 15 percent. The two lakes lie on two unnamed tributaries of the Big River. Cedar Hill Lake No. 2 is linked with Cedar Hill Lake No. 3 by a 15-foot wide connecting channel.

Elevations within the two watersheds range from approximately 520 feet above MSL at the damsites to over 757 feet above MSL in the upper portion of the watersheds.

The two watersheds are approximately 90 percent covered with forest, with the remainder being covered by grass, brush, houses and roads. A drainage map showing the two watershed areas is included in Appendix B.

Evaluation of the hydraulic and hydrologic features of Cedar Hill Lake No. 2 and No. 3 Dams were based on criteria set forth in the Corps of Engineers Recommended Guidelines for Safety Inspection of Dams, and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Preciptation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at

24 hours, and storm rainfall distribution was based on criteria given in EM 1110-2-1411 (Standard Project Storm). The SCS triangular hydrograph, transformed to a curvilinear hydrograph, was adopted for developing the unit hydrograph. The derived unit hydrograph is presented in Appendix B.

Initial and infiltration loss rates were applied to the PMP to obtain rainfall excesses. The rainfall excesses were then applied to the unit hydrograph to obtain the PMF hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version), which was prepared specifically for dam safety analysis. The computed peak discharge of the PMF and one-half of the PMF for Cedar Hill Lake No. 2 Dam are 4,950 cfs and 2,295 cfs, respectively, and that for Cedar Hill Lake No. 3 Dam are 1,089 cfs and 545 cfs, respectively.

As mentioned earlier, Cedar Hill Lake No. 2 and Cedar Hill Lake No. 3 are linked by a connecting channel. Therefore, for reservoir flood routing purposes, both reservoirs are treated as one single reservoir with two spillways. (An accurate determination of balancing effect of the channel is beyond the scope of a Phase I investigation.) The lower spillway, with crest elevation at 540 feet, is at Lake No. 2, and the higher spillway, with crest elevation at 543.5 feet, is at Lake No. 3. Reservoir routing starts at water level elevation at the crest of the lower spillway.

The PMF and one-half of the PMF inflow hydrographs for Cedar Hill Lake No. 2 and Cedar Hill Lake No. 3 were combined as the PMF and one-half of the PMF inflow hydrographs into a single reservoir for routing. The peak discharge of the PMF and one-half of the PMF for reservoir routing are 5,292 cfs and 2,646 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. The peak outflow discharges for the PMF and one-half of the PMF are 4,897 cfs and 1,558 cfs, respectively. Only the PMF, when routed through the reservoir, resulted in overtopping of the dams.

The stage-outflow relation for the spillways were prepared from field notes and sketches. The reservoir stage-capacity data were based on the U.S.G.S. quadrangle topographic maps in combination with data given in the National Dam Safety Inventory Table. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curve assumed that the dam remains intact during routing. The spillway rating curves and the reservoir capacity curves are also presented in Appendix B.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. However, according to the owner, the highest reservoir level in Cedar Hill lake No. 2 was above 3 feet over the spillway in 1975, and the highest reservoir level in Cedar Hill Lake No. 3 was about 6 inches over the spillway in 1975.

c. Visual Observations

The concrete weir at the spillway entrance in Cedar Hill Lake No. 2 Dam is in poor condition. The rock at the exit channel of the spillway is in good condition with no obstructions. The spillway and the exit channel are located at the furthermost left abutment, and the spillway releases will not adversely affect the stability of the dam.

The spillway crest in Cedar Hill Lake No. 3 Dam is in satisfactory condition. However, the spillway discharge channel downstream from the crest is full of debris and trees, and is in poor condition.

Since there is no definite exit channel, and the spilway discharge channel of Cedar Hill Lake No. 3 Dam is so close to the private house at the dam toe, heavy spillway releases would cause damage to this property.

None of the dams have any drawdown facilities to evacuate the reservoir.

d. *Overtopping Potential*

As indicated in Paragraph 5.1-a., only the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of Cedar Hill Lake No. 2 and No. 3 Dams. The PMF overtopped the dams by 0.77 feet. The total duration of embankment overflow is 0.75 hours during the PMF. The total capacity of the spillways of the Cedar Hill Lake No. 2 Dam and the Cedar Hill No. 3 Dam is capable of passing a flood equal to approximately 55 percent of the PMF just before overtopping of the dams. The 55 percent PMF has a frequency of occurrence less than a 100-year frequency flood. Since one-half of the PMF is the minimum Spillway Design Flood (SDF) for Cedar Hill Lake No. 2 Dam and Cedar Hill Lake No. 3 Dam, according to the Recommended Guidelines for Safety Inspection of Dams by the Corps, the spillway capacities of the dams are considered "Adequate".

The effect from rupture of Cedar Hill Lake No. 2 Dam could extend approximately two miles downstream of the dam. Within this area are six houses, two improved road crossings, and State Highway 30 crossing.

The effect from rupture of Cedar Hill Lake No. 3 Dam could extend approximately two miles downstream of the dam. Within this area are five houses, one house is located immediately downstream of the toe of the dam, and the County Road B crossing is also within the damage zone.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

Cedar Hill No. 2 Dam

a. Visual Observations

Inspection suggests the existence of a sliver-fill on the east side of the dam, placed against a steep slope of a bedrock ridge, to provide vehicular access to the crest of the dam. To complicate the situation, a ditch has been excavated into the ridge near the contact between rock and fill, has been left unlined, and contains standing (or flowing) water during a portion of the year.

Therefore, water can pass from the ditch through the bedrock and move along the fill-rock contact (causing erosion and seepage at the toe of the fill), or become entrapped along the contact (building up hydrostatic pressure). This is the likely explanation for the seepage near the right abutment of the dam.

It is recommended that the toe of the dam near the right abutment be watched closely in the future. Any changes in the quantity, location or color of the seepage flow should be reported and an engineering study performed.

The heavy vegetative growth, including large trees, on the downstream embankment slope should be cleared as soon as possible. The growth prevents proper inspection of the embankment in addition to providing a hazard to the embankment.

The deficiencies on the spillway, as described in Sections 4 and 5, do not appear to pose any adverse affect on the structural stability of the dam.

Cedar Hill Lake No. 3 Dam

The heavy vegetative growth, including large trees, on the downstream embankment slope should be cleared as soon as possible. The growth prevents proper inspection of the embankment, in addition to providing a hazard to the embankment.

The extensive sloughing of materials on the upstream embankment slope should be repaired. Further erosion of the embankment section would jeopardize the structural stability of the embankment section.

There is no apparent structural instability with the spillway. However, the debris and trees located in the spillway discharge channel, if allowed to remain, would direct water flows over the spillway channel towards the downstream slope of the embankment, which would adversely affect the structural stability of the dam.

b. Design and Construction Data

No design or construction data relating to the structural stability of the dam or appurtenant structures was found.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. Water levels have not been recorded, however, the water level was 1.0 feet below the spillway crest on the day of inspection, and is assumed to be close to full at all times. No operating facilities exist at the damsite.

d. Post Construction Changes

No post construction changes are known which will affect the structural stability of the dam.

e. Seismic Stability

In general projects located in Seismic Zones 0, 1 and 2 can be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist. Cedar Hill Lake No. 2 Dam and Cedar Hill Lake No. 3 Dam are located in Seismic Zone 1. A detailed seismic analysis is not felt to be necessary for these embankments.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Cedar Hill No. 2 and No. 3 Dams are capable of passing a flood equal to 55 percent of the PMF without overtopping. It was also found to be capable of passing the 100-year flood. The general physical condition of the dams is considered fair.

The downstream embankment section located between Cedar Hill Lakes No. 2 and No. 3, described in detail in Section 6, should be watched closely and any changes in the quantity, location or color of the seepage should be reported.

The heavy brush and trees on the embankment slope of both dams posses a potential hazard to the dams. Tree growth is considered unsatisfactory for several reasons: First, trees toppled by wind expose holes that invite rapid erosion and, second, decay of large existing root systems could form channels for eventual piping.

The vegetative growth in the spillway channels of both dams inhibits the hydraulic efficiency of the structure, and should be cleared, with future growth prevented.

The extensive sloughing of embankment materials on the steep upstream slope of dam No. 3 should be controlled. Erosion protection should be provided to control the sloughing.

The discharge channel for the spillway of dam No. 3 should be modified. The present route for spillway discharges would proceed directly toward the house located downstream of the dam, and across a gravel road.

A channel should be constructed to transport approximately 50 cfs (maximum spillway discharge) past the house, under the road, and into the downstream channel.

b. Adequacy of Information

Information concerning the dam and appurtenant structures is not available. It is recommended that the following programs be initiated to help alleviate this problem:

1. Periodic inspection of the dam by an engineer experienced in the design and construction of dams.

2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. The dam should be surveyed and an as-built set of plans and drawings should be completed.

4. Perform seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams".

c. Urgency

The remedial actions recommended in Paragraph 7.2 should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Watch closely the area exhibiting seepage downstream of the right abutment of dam No. 2 for any changes in the quantity, location or color of the seepage flow. Any such change should be reported and an engineering study performed.

b. Clear the downstream embankment slope of all trees and large brush. Future growth should be prevented. This clearing should be performed under the direction of a professional engineer experienced in design and construction of earth dams.

c. Control the embankment sloughing on the upstream slope of Dam No. 3.

d. Modify the existing spillway discharge channel of dam No. 3 to route potential flows past the house and road downstream of the dam. Clear trees and debris from the existing spillway channel.

e. O & M Maintenance and Procedures

The owner should initiate the following programs:

1. Periodic inspection of the dam by an engineer experienced in the design and construction of dams.

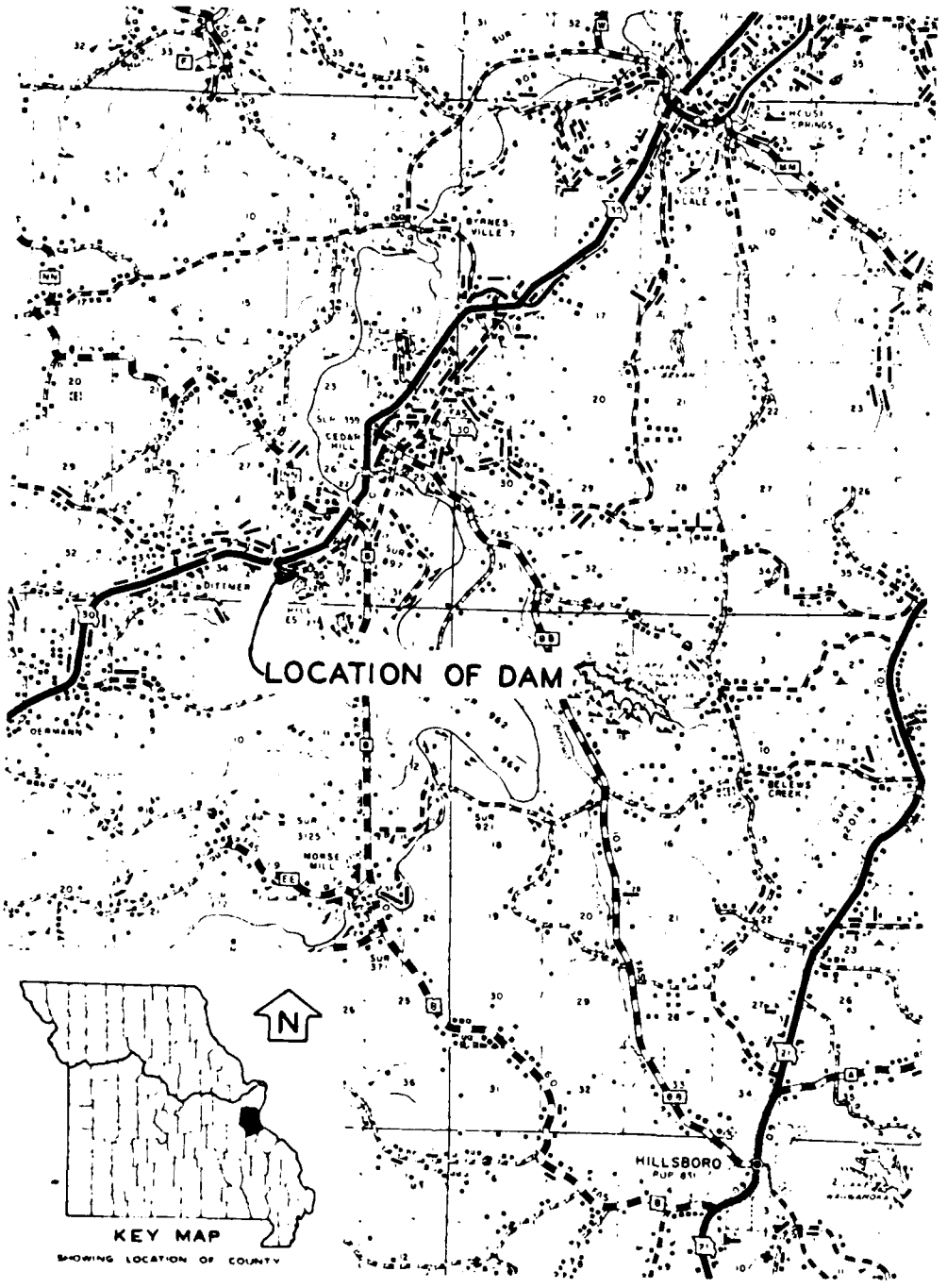
2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. Clear the vegetative growth from the spillway channel.

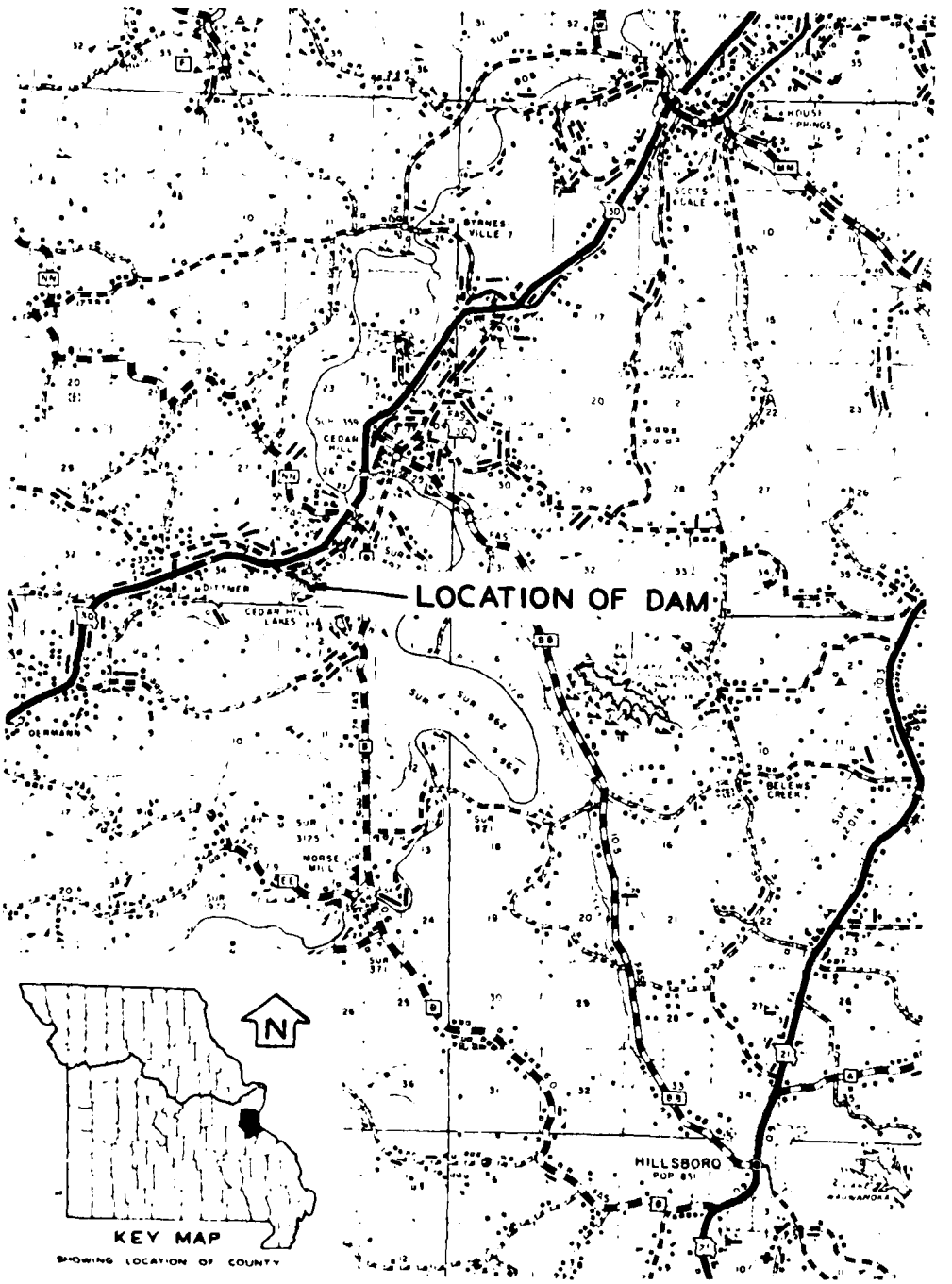
4. The dam should be surveyed and an as-built set of plans and drawings should be completed.

5. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

PLATES

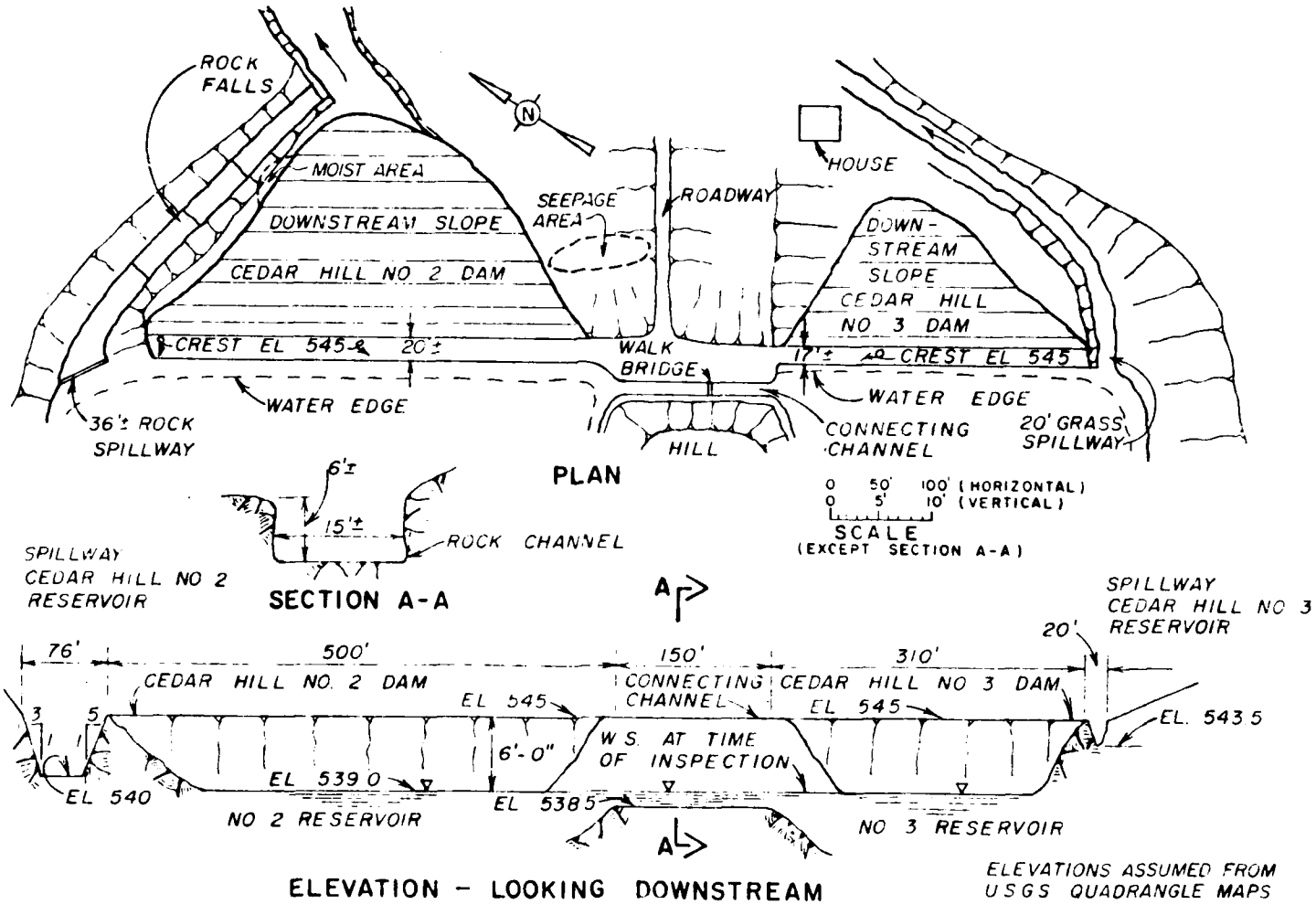


LOCATION MAP
CEDAR HILL LAKE NO.2 DAM
JEFFERSON COUNTY, MISSOURI

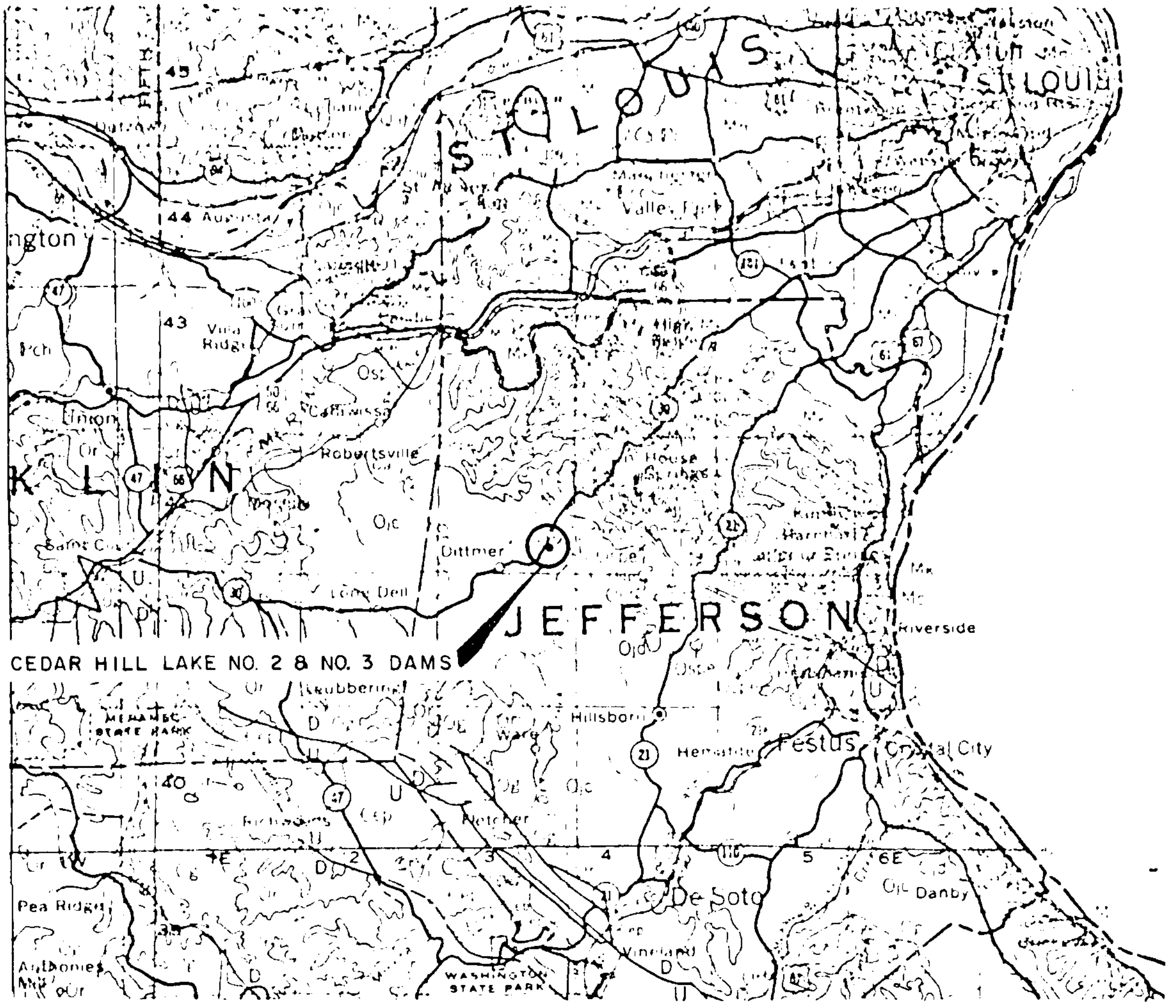


LOCATION MAP
CEDAR HILL LAKE NO.3 DAM
JEFFERSON COUNTY, MISSOURI

CEDAR HILL LAKE NO. 2 & NO. 3 DAMS
RELATIVE ELEVATIONS



ELEVATIONS ASSUMED FROM USGS QUADRANGLE MAPS



General Geologic Map

Explanation

Mississippian System

M_o - cherty and crinoidal limestone, with some shale.
M_k - intercalated limestones and shales.

Ordovician System

O_{mk} - shale and limestone.
O_{dp} - shale with thin fossiliferous limestone beds and dense limestone.
O_{jd} - dolomite with interbedded limestone, shale, and black limestone.
O_{spe} - massive, cross-bedded sandstone; and dolomite, lithographic limestone with interbedded sandstone.
O_{jc} - silty and cherty dolomite with oolitic chert.
O_r - sandstone, chert, and interbedded dolomite.
O_g - cherty dolomite with a basal sandstone.

Reference: Geologic Map of Missouri, 1961, Division of Geological Survey and Water Resources, State of Missouri.

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

CEDAR HILL LAKE DAM NO. 2

Photo 1 - View along crest of dam taken from right abutment.

Photo 2 - View along upstream slope of dam taken from left abutment.

Photo 3 - Picture of cleared area on downstream embankment slope. Typical slope vegetation is shown on either side of cleared area.

Photo 4 - Picture of line of piezometers along downstream toe of embankment below cleared area.

Photo 5 - View through connecting channel looking toward lake No. 2.

Photo 6 - Picture of upstream slope of embankment. Note spillway at left side of dam.

Photo 7 - Picture of approach channel for spillway. Note torn trash-rack screen.

Photo 8 - Picture of spillway channel taken from spillway crest looking downstream.

Photo 9 - Picture of spillway channel bedrock taken from downstream looking upstream.

Photo 1 - View along crest of dam taken from right abutment.

Photo 2 - View along upstream slope of dam taken from left abutment.

Photo 3 - Picture of cleared area on downstream embankment slope. Typical slope vegetation is shown on either side of cleared area.

Photo 4 - Picture of line of piezometers along downstream toe of embankment below cleared area.

Photo 5 - View through connecting channel looking toward lake No. 2.

Photo 6 - Picture of upstream slope of embankment. Note spillway at left side of dam.

Photo 7 - Picture of approach channel for spillway. Note corn trashrack screen.

Photo 8 - Picture of spillway channel taken from spillway crest looking downstream.

Photo 9 - Picture of spillway channel bedrock taken from downstream looking upstream.

CEDAR HILL LAKE DAM NO. 3

Photo 1 - View along crest of dam taken at left abutment.

Photo 2 - View along upstream slope of embankment taken from left abutment.

Photo 3 - Close-up of typical section of upstream embankment slope.

Photo 4 - Picture of typical section of downstream embankment slope.

Photo 5 - Picture of connecting channel between lakes taken from right of lake No. 3.

Photo 6 - Close-up of connecting channel with bridge.

Photo 7 - Picture of right side of dam. Note spillway approach at right abutment.

Photo 8 - View across spillway channel at right side of dam.

Photo 9 - Picture of spillway approach and channel taken from right abutment of dam.

Photo 1 - View along crest of dam taken at left abutment.

Photo 2 - View along upstream slope of embankment taken from left abutment.

Photo 3 - Close-up of typical section of upstream embankment slope.

Photo 4 - Picture of typical section of downstream embankment slope.

Photo 5 - Picture of connecting channel between lakes taken from right of lake No. 3.

Photo 6 - Close-up of connecting channel with bridge.

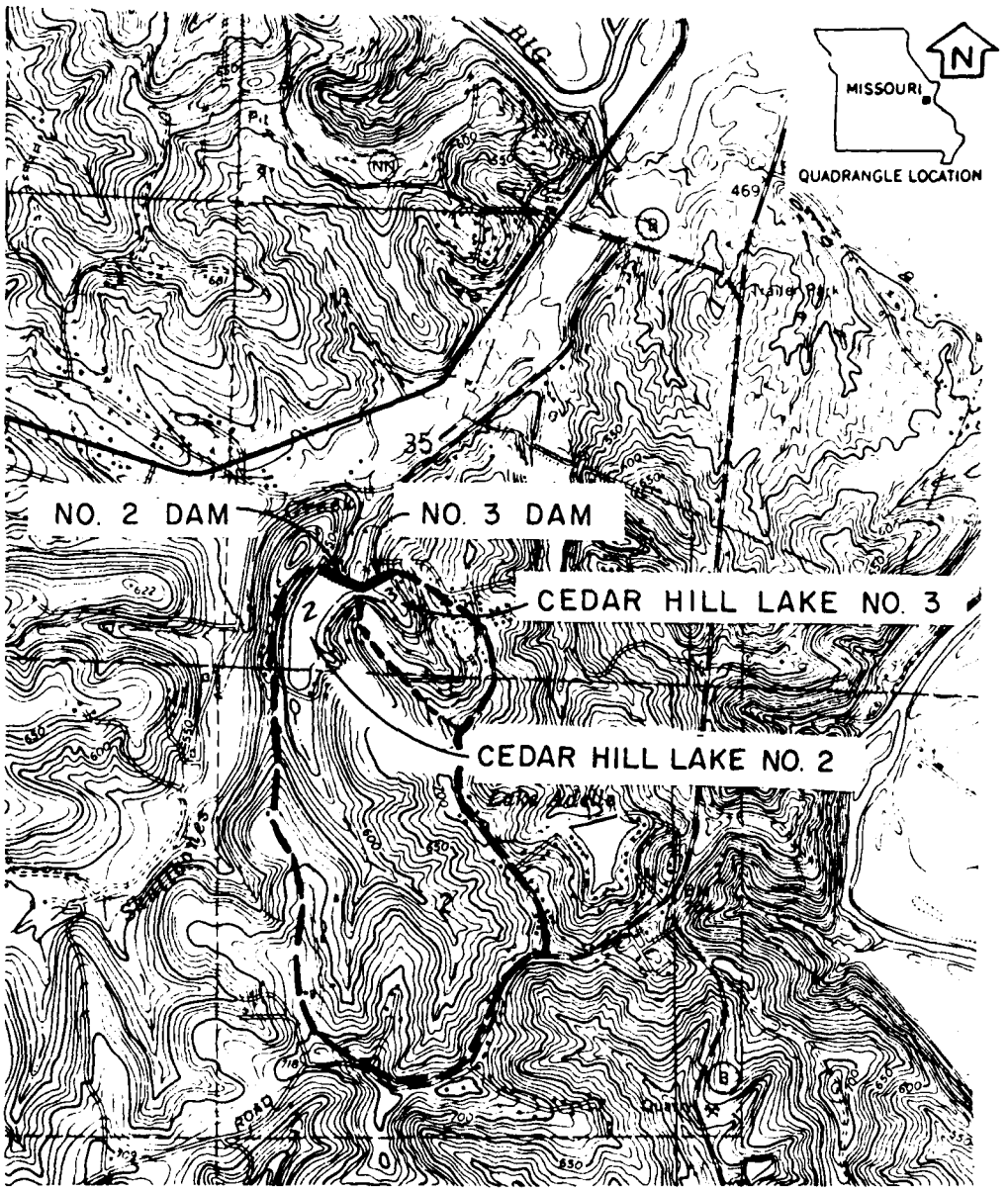
Photo 7 - Picture of right side of dam. Note spillway approach at right abutment.

Photo 8 - View across spillway channel at right side of dam.

Photo 9 - Picture of spillway approach and channel taken from right abutment of dam.

APPENDIX B

HYDROLOGIC COMPUTATIONS



CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

DRAINAGE BOUNDARY — — — — —

CEDAR HILL LAKE NO. 2 & NO. 3 DAMS
DRAINAGE AREA

ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION – MISSOURI
CEDAR HILL LAKE #2 DAM
RESERVOIR AREA CAPACITY DATA

SHEET NO. 1 OF 2
JOB NO. 1223-001-1
BY KLB DATE 11-12-78

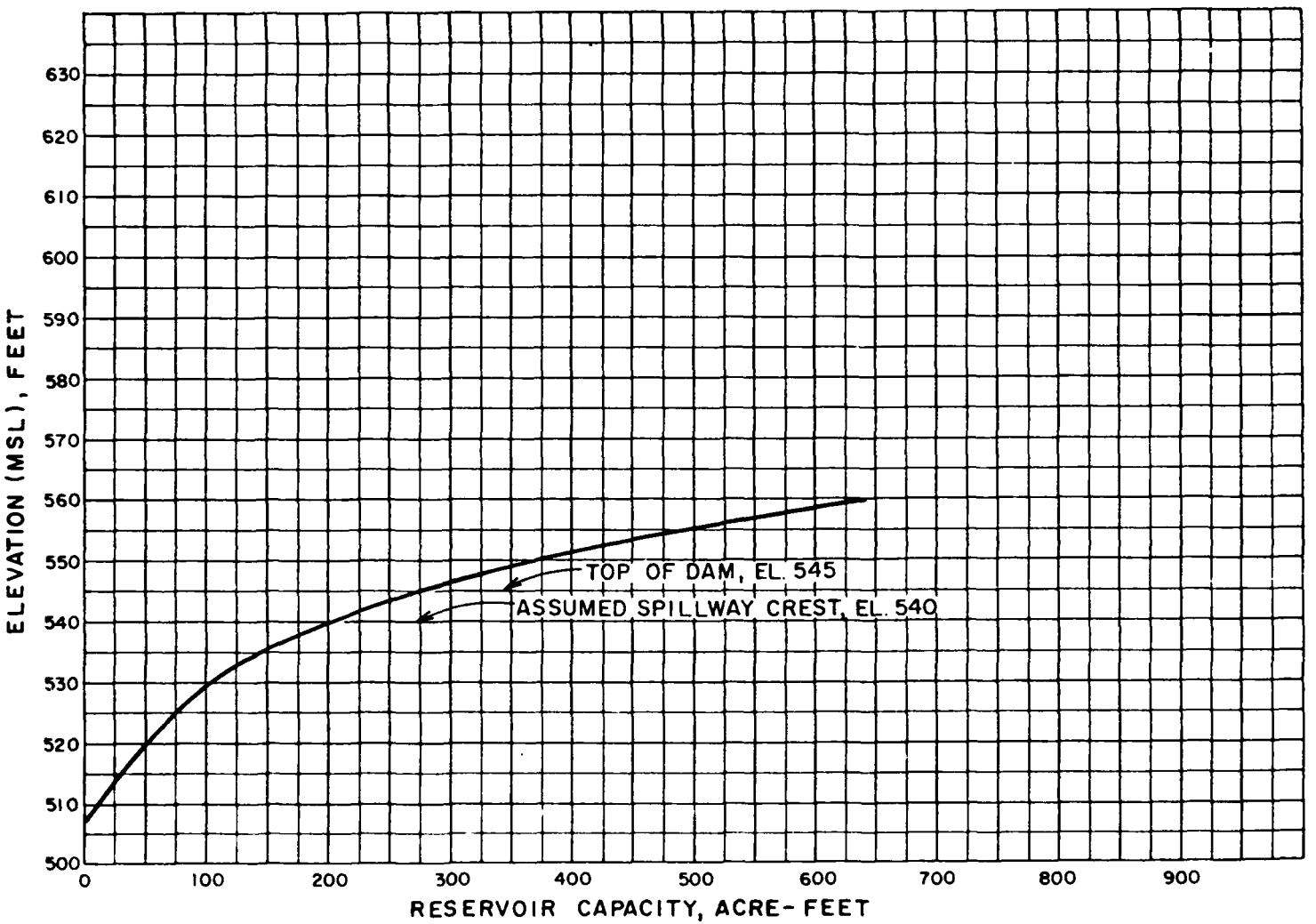
CEDAR HILL LAKE #2 DAM

RESERVOIR AREA CAPACITY DATA.

ELEVATION (FT)	SURFACE AREA (ACRES)	INCREMENTAL VOLUME (AC-FT)	TOTAL VOLUME (AC-FT)	REMARKS
507	0	–	0	
540	12	132	198	ASSUMED SPILLWAY CREST ELEVATION (AREA MEASURED ON U.S.G.S. MAP)
545	18*	75	273	TOP OF DAM
550	23	103	376	AREA MEASURED ON U.S G.S. MAP
560	30	265	641	AREA MEASURED ON U.S.G.S. MAP
570	40	350	990	AREA MEASURED ON U.S G.S. MAP

* INTERPOLATED DATA.

CEDAR HILL LAKE # 2 DAM
RESERVOIR CAPACITY CURVE



ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI
CEDAR HILL LAKE #3 DAM
RESERVOIR AREA - CAPACITY DATA

SHEET NO. 1 OF
JOB NO. 1223-001-1
BY KLB DATE 11-17-78

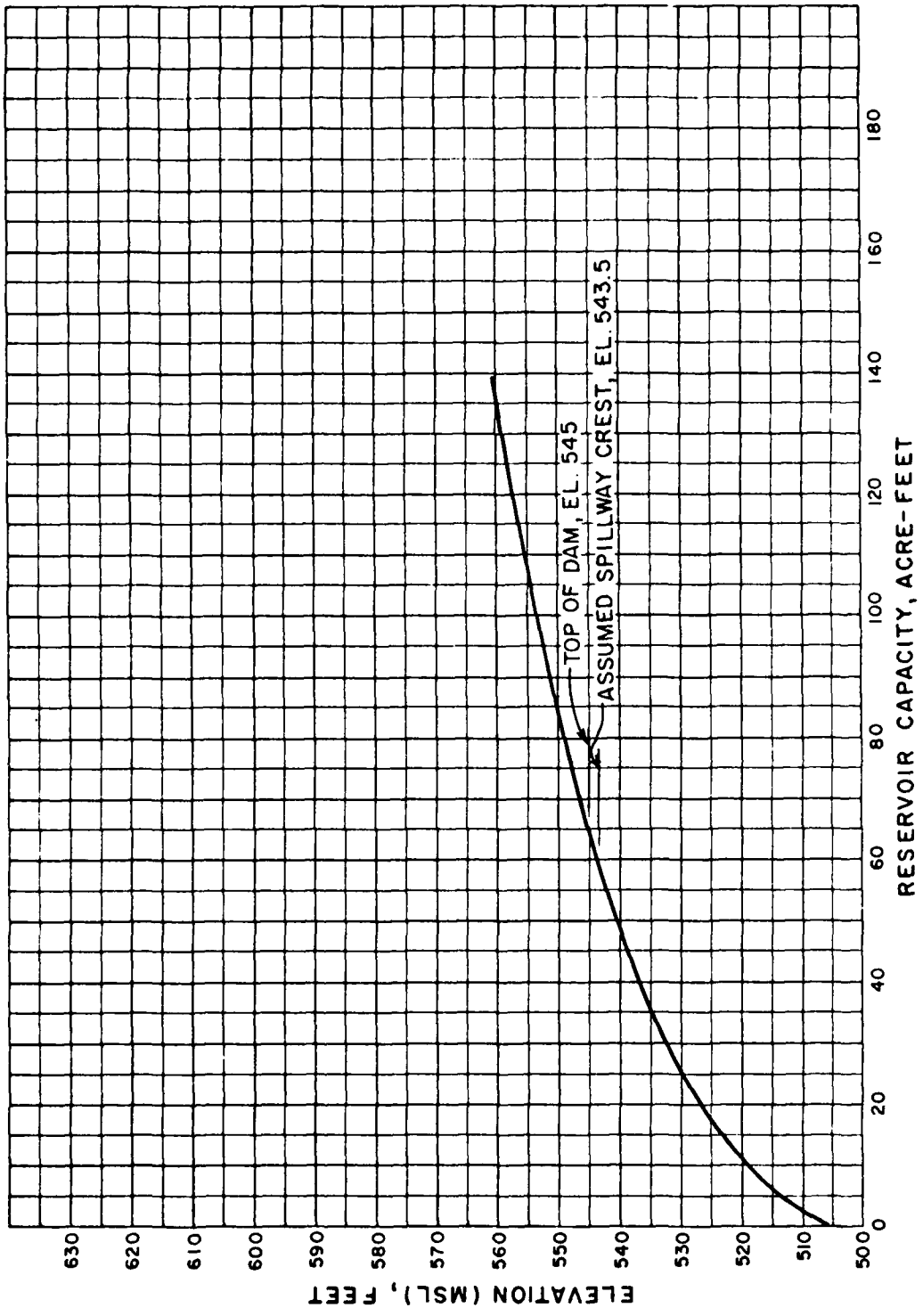
41ª

CEDAR HILL LAKE #3 DAM

RESERVOIR AREA CAPACITY DATA

ELEVATION (FEET)	SURFACE AREA (ACRES)	INCREMENTAL VOLUME (AC-FT)	TOTAL VOLUME (AC-FT)	REMARKS
506	0	–	0	
593.5	3.2*	60	60	ASSUMED SPILLWAY CREST ELEVATION
595	3.6*	5	65	TOP OF DAM
550	4	19	84	AREA MEASURED ON U.S.G.S. MAP
560	7	55	139	AREA MEASURED ON U.S.G.S. MAP

* INTERPOLATED DATA



CEDAR HILL LAKE # 3 DAM
RESERVOIR CAPACITY CURVE

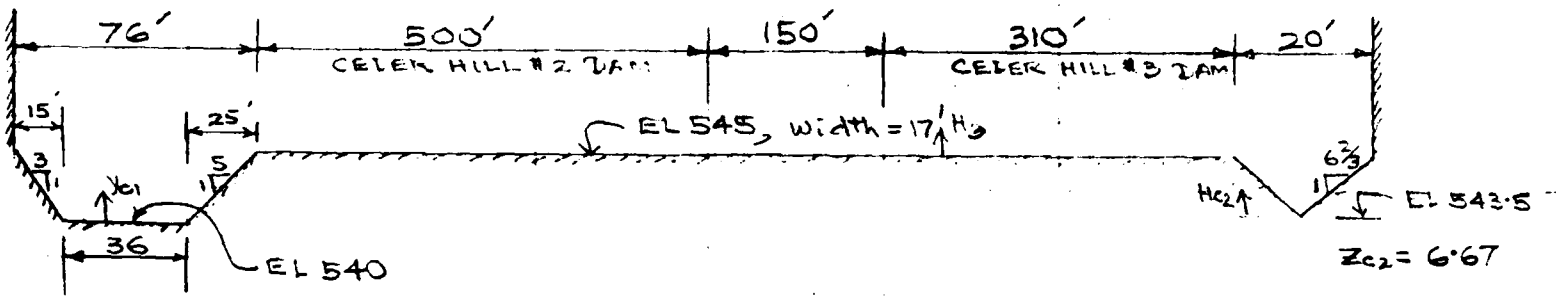
ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI
CEDAR HILL LAKE #2 & #3 DAMS
COMBINED AREA CAPACITY CURVE

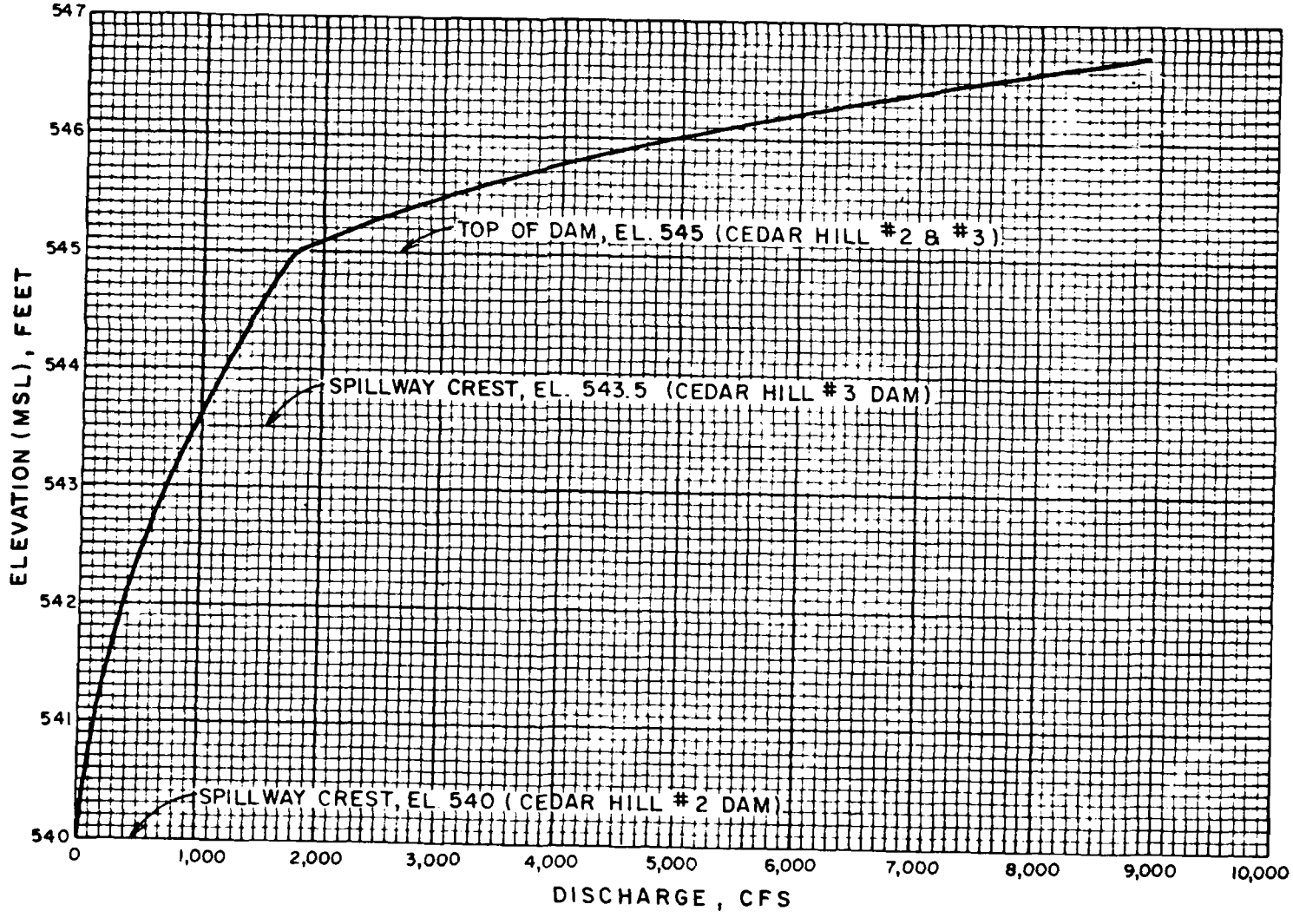
SHEET NO. 1 OF 1
JOB NO. 1223-001-1
BY KLB DATE 11-27-78

ELEV. FT.	STORAGE (AC-FT)		COMBINED (AC-FT)
	DAM 2	DAM 3	
506	—	0	0
507	0	0.9*	0.9
540	198	49.5*	247.5*
543.5	248*	60	308*
545	273	65	338
550	376	84	460
560	641	139	780

* INTERPOLATED DATA



Y_{c1}	T_{c1}	A_{c1}	$Y_{c1} = 5.67\sqrt{\frac{A_{c1}}{T_{c1}}}$	$\frac{V_{c1}^2}{2g}$	Q_{c1}	Upstream W.S. EL $= E_1 = 540 + Y_{c1} + \frac{V_{c1}^2}{2g}$	$H_{c2} = E_1 - 543.5$	$Q_{c2} = 2.295 \times Z_{c2} H_{c2}^{2.5}$	H_3	C_3	L_3	Q_3	$Q_T = Q_{c1} + Q_{c2} + Q_3$
1	44	40	5.41	0.45	216	541.45							216
2	52	88	7.38	0.84	649	542.84							649
3	60	144	8.78	1.20	1264	544.2	0.70	6					1270
3.5	64	175	9.38	1.37	1642	544.87	1.37	34					1676
4	68	208	9.92	1.53	2063	545.53	2.03	90	0.53	2.70	960	1000	3153
5	76	265	10.59	1.74	2806	546.74	3.24	289	1.74	2.63	960	5795	8890



CEDAR HILL LAKE #2 & #3 DAMS
COMBINED SPILLWAYS & OVERTOP
RATING CURVE

EC1-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI
CEDAR HILL LAKE #2 DAM
UNIT HYDROGRAPH PARAMETERS

SHEET NO. 1 OF 2
JOB NO. 1223-001-1
BY KLB DATE 10-31-78
Jim

1. DRAINAGE AREA = 270 AC = 0.42 SQ. MI

2. LENGTH OF STREAM, $L = \frac{2.8'' \times 2000'}{5280} = 1.06$ MI.

3. DIFFERENCE IN ELEV. = 755 - 540 = 215 FT.

4. TIME OF CONCENTRATION, T_c

$$T_c = \left(\frac{11.9 \times L^3}{\Delta H}\right)^{0.385}$$

$$= \left(\frac{11.9 \times 1.06^3}{215}\right)^{0.385}$$

T_c = 0.35 HR.

5. LAG TIME, $L_t = 0.6 \times T_c$

$L_t = 0.6 \times 0.35$ = 0.21 HR

6 RAINFALL UNIT DURATION, D

$D \leq \frac{L_t}{4} = \frac{0.21}{4} = 0.05$ HR

USE D = 5 MIN = 0.083 HR

(MINIMUM DURATION CRITERIA)

7. TIME TO PEAK, T_p

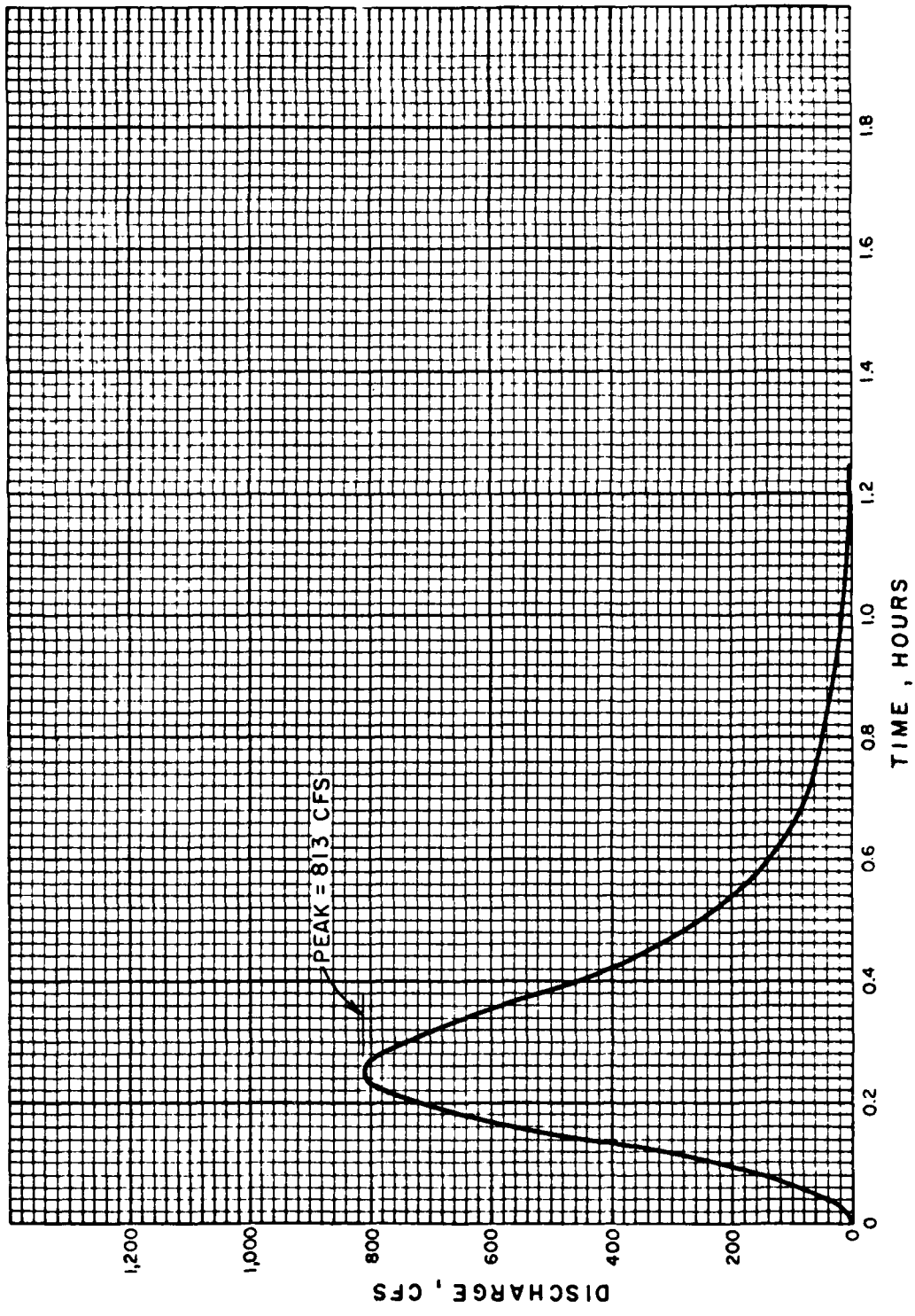
$$T_p = \frac{D}{2} + 0.6 \times T_c$$

$$T_p = \frac{0.083}{2} + 0.6 \times 0.35 = 0.25 \text{ HR.}$$

8 $q_p = \frac{484 \times A}{T_p} = \frac{484 \times 0.42}{0.25}$ = 813 CFS

9) CURVILINEAR UNIT HYDROGRAPH

TIME, T T/Tp	DISCHARGE RATIO Q/Qp	UNIT HYDROGRAPH TIME, T (HR)	UNIT HYDROGRAPH DISCHARGE Q (CFS)
0.0	0.000	0.000	0.000
0.1	0.015	0.03	12.20
0.2	0.075	0.05	60.98
0.3	0.16	0.08	130.08
0.4	0.28	0.10	227.69
0.5	0.45	0.13	365.85
0.6	0.60	0.15	487.80
0.7	0.77	0.18	626.01
0.8	0.89	0.20	723.57
0.9	0.97	0.23	788.61
1.0	1.00	0.25	813.00
1.1	0.98	0.28	796.74
1.2	0.92	0.30	747.96
1.3	0.84	0.33	682.92
1.4	0.75	0.35	609.75
1.5	0.66	0.38	536.58
1.6	0.56	0.40	455.28
1.8	0.42	0.45	341.46
2.0	0.32	0.50	260.16
2.2	0.24	0.55	195.12
2.4	0.18	0.60	146.34
2.6	0.13	0.65	105.69
2.8	0.098	0.70	79.67
3.0	0.075	0.75	60.98
3.5	0.036	0.88	29.27
4.0	0.018	1.00	14.63
4.5	0.009	1.13	7.32
5.0	0.004	1.25	3.25



CEDAR HILL LAKE NUMBER 2 DAM
5 MINUTE UNIT HYDROGRAPH

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - Missouri — SHEET NO. 1 OF 2
CEDAR HILL LAKE #3 DAM — JOB NO. 1223-001-1
UNIT HYDROGRAPH PARAMETERS — BY KLB DATE 11-3-78

1. DRAINAGE AREA = 36 AC = 0.06 SQ. MI.

2. LENGTH OF STREAM, L = (0.7" x 2000'/5280) = 0.27 MI.

3. DIFFERENCE IN EL., ΔH = 705 - 540 = 165 FT.

4. TIME OF CONCENTRATION, T_c

$$T_c = \left(\frac{11.9 \times L^3}{\Delta H}\right)^{0.385}$$

$$T_c = \left(\frac{11.9 \times 0.27^3}{165}\right)^{0.385}$$

$$T_c = 0.081 \text{ HR}$$

5. LAG TIME, $L_t = 0.6 \times T_c$

$$L_t = 0.6 \times 0.081 = 0.049$$

6. RAINFALL UNIT DURATION, D

$$D \leq \frac{L_t}{4} = \frac{0.049}{4} = 0.012$$

USE $D = 5\text{MIN} = 0.083$ HR

MINIMUM DURATION CRITERIA

7. TIME TO PEAK, T_p

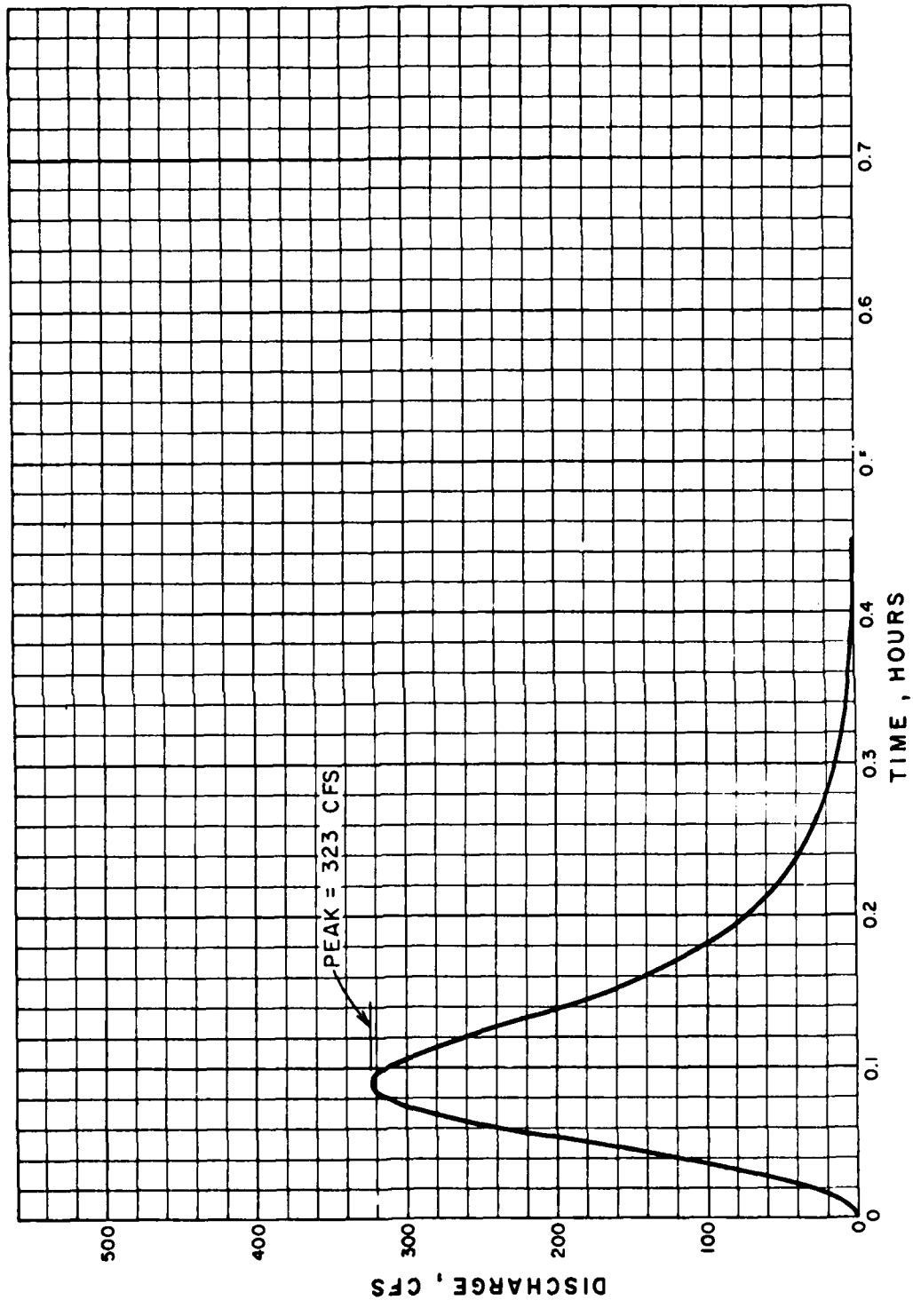
$$T_p = \frac{D}{2} + 0.6 \times T_c$$

$$T_p = \frac{0.083}{2} + 0.6 \times 0.081 = \underline{0.09 \text{ HR}}$$

8. $q_p = \frac{484 \times A}{T_p} = \frac{484 \times 0.06}{0.09} = \underline{323 \text{ CFS.}}$

9) CURVILINEAR UNIT HYDROGRAPH

TIME T/Tp	DISCHARGE RATIO q/qp	UNIT HYDROGRAPH	
		TIME T (HR)	DISCHARGE (CFS)
0,00	0,000	0,00	0,00
0,1	0.015	0,01	4.85
0.2	0,075	0,02	24,23
0.3	0.16	0,03	51.68
0,4	0.28	0.04	90,44
0.5	0,45	0,05	145,35
0.6	0,60	0.05	193,80
0.7	0.77	0.06	248.71
0,8	0,89	0,07	287,47
0.9	0.97	0,08	313,31
1.0	1,00	0,09	323,00
1.1	0.98	0,10	316,54
1,2	0,92	0,11	297.16
1,3	0.84	0,12	271.32
1,4	0,75	0,13	242.25
1.5	0.66	0.14	213,18
1.6	0.56	0,14	180.88
1.8	0,42	0.16	135,66
2,0	0,32	0,18	103,36
2.2	0.24	0,20	77,52
2,4	0,18	0,22	58.14
2,6	0,13	0.23	41,99
2.8	0.098	0,25	31,65
3.0	0,075	0.27	24.23
3,5	0.036	0,32	11,63
4,0	0,018	0.36	5.81
4,5	0,009	0.41	2,91
5.0	0.004	0,45	1,29



CEDAR HILL LAKE NUMBER 3 DAM
5 MINUTE UNIT HYDROGRAPH

ECI-4 ENGINEERING CONSULTANTS, INC.

LAKE SAINTE LOUISE/MISSOURI SHEET NO. 1 OF ___
CEDER HILL LAKE NUMBER 2 DAM JOB NO. 1223-001
PROBABLE MAXIMUM STORM (PMS) BY MAS DATE

DETERMINATION OF PMS

1. Determine drainage area of the basin

   D.A. = 270 acres = 0.42 Sq. mi.

2. Determine PMP Index rainfall :

   Location of centroid of basin:

   Long. 90.66°; Lat.: 38.32°

   → PMP for 200 Sq. mi. & 24 hrs duration

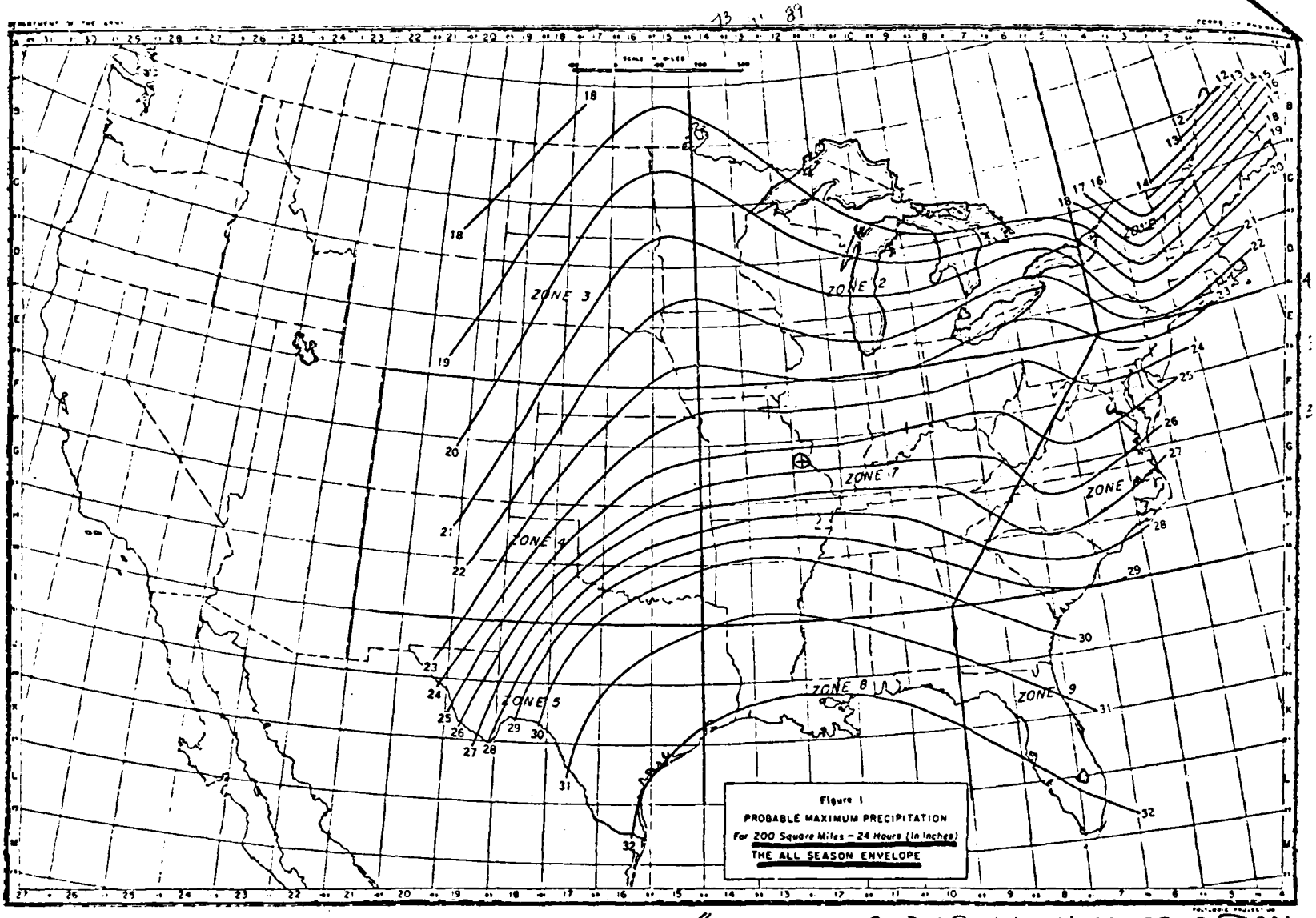
   = 25.6" (from Fig 1, HMR NO 33)

3. Determine basin rainfall interms of percentage of PMP Index rainfall for various durations;

   Location: Long. 90.66°; Lat. 38.32°

   ⇒ Zone 7

Duration (Hrs.)	Percent of Index rainfall (%)	Total rainfall (Inches)	Rainfall increments (Inches)	Duration of increment (Hrs.)
6	100	25.6	25.6	6
12	120	30.7	5.1	6
24	130	33.3	2.6	12



25.6"

CEDER HILL NUMBER 2 DAM
DETERMINATION OF PMP

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION/MISSOURI — SHEET NO. 1 OF 2
CEDER HILL LAKE #3 DAM — JOB NO. 1223-001
PROBABLE MAXIMUM STORM (PMS) — BY MAS DATE 11/20/78

DETERMINATION OF PMS

1. Determine drainage area of the basin

   D.A. = 36 acres = 0.056 Sq.mi.

2. Determine PMP Index rainfall:

   Location of centroid of basin:

   Long. 90.66°; Lat.: 38.33°

   → PMP for 200 Sq.mi. & 24 hrs duration
   = 25.6" (from Fig 1, HMR No 33)

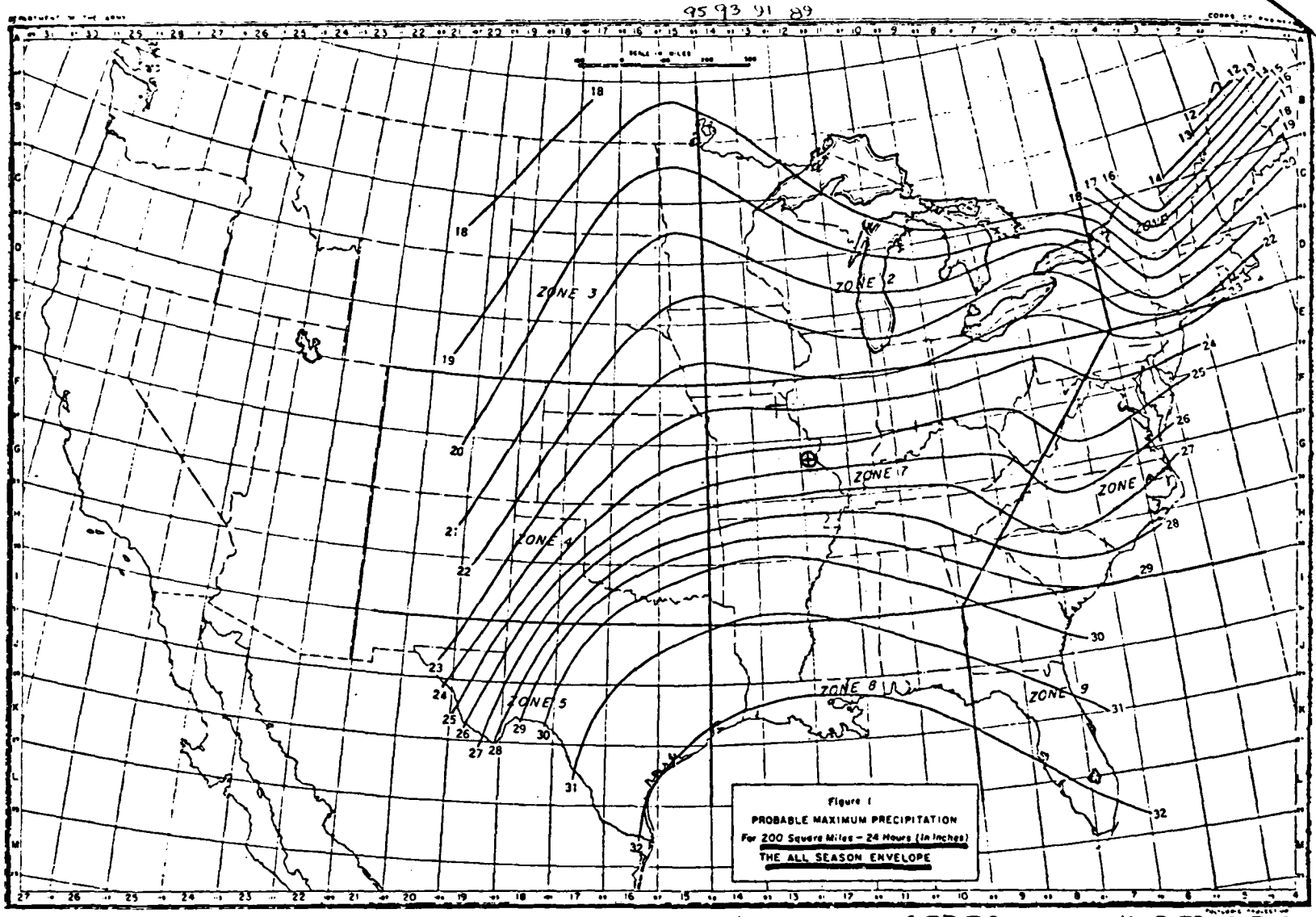
3. Determine basin rainfall in terms of percentage of PMP Index rainfall for various durations:

   Location: Long. 90.66°; Lat. 38.33°

   ⇒ Zone 7

Duration (Hrs.)	Percent of Index rainfall (%)	Total rainfall (Inches)	Rainfall increments (Inches)	Duration of increment (Hrs.)
6	100	25.6	25.6	6
12	120	30.7	5.1	6
24	130	33.3	2.6	12

95 93 91 89



25.6"

CEDER HILL NUMBER 3 DAM
DETERMINATION OF PMP

20

39

37

20

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF 1
CEDAR HILL LAKE #2 DAM JOB NO. 1223-001-1
100-YEAR FLOOD BY REGRESSION EQUATION BY KLB DATE 11-20-78
Jim

CEDAR HILL DAM #2

100 YEAR FLOOD BY REGRESSION EQUATION

REGRESSION EQUATION FOR 100-YEAR FLOOD FOR MISSOURI:

$$Q_{100} = 85.1\, A^{0.934A^{-0.02}}\, S^{0.576}$$

WHERE:

A = DRAINAGE AREA IN SQ. mi.

S = MAIN CHANNEL SLOPE, Ft/mi.
(AVG. SLOPE BETWEEN 0.1L AND 0.85L,
L, BEING LENGTH OF THE STREAM)

FOR. CEDAR HILL #2 DAM

A = 0.42 mi.

$$S = \frac{652 - 545}{0.75 \times 1.06} = 134.59 \text{ Ft/mi}$$

$$Q_{100} = 85.1 \cdot (0.42)^{0.934(0.42)^{-0.02}} (134.59)^{0.576}$$

$$= \underline{628} \text{ CFS}$$

CEDAR HILL DAM #3

100 YEAR FLOOD BY REGRESSION EQUATION

REGRESSION EQUATION FOR 100-YEAR FLOOD FOR MISSOURI;

$$Q_{100} = 85.1\, A^{0.934\, A^{-0.02}}\, S^{0.576}$$

WHERE

A = DRAINAGE AREA IN SQ. MI.

S = MAIN CHANNEL SLOPE, FT/MI
(AVG SLOPE BETWEEN 0.1L AND 0.85L,
L, BEING LENGTH OF THE STREAM)

FOR CEDAR HILL #3 DAM

$A = 0.06$ SQ. MI.

$$S = \frac{635 - 548}{0.75 \times 0.27} = \frac{87}{0.20} = 429.63 \text{ FT/MI}$$

$$Q_{100} = 85.1\,(0.06)^{0.934\,(0.06)^{-0.02}}\,(429.63)^{0.576}$$

$$= \underline{174 \text{ CFS}}$$

HEC1DB INPUT DATA

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
 LAST MODIFICATION  21 AUG 78
**********
    1          A1                    DAM SAFETY INSPECTION - MISSOURI
    2          A2                    CEDAR HILL LAKE NUMBER 2 AND 3 DAMS
    3          A3              PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING
    4          B    300        0        5        0        0        0        0        0        0        0
    5          B1     5
    6          J      1        2        1
    7          J1   1.0      0.5
    8          K      0       15                                          1
    9          K1     INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNIT HYDROGRAPH DAM 2
   10          M      1       -1     0.42             0.42      1.0
   11          P             25.6      100      120      130
   12          T                                                  1.00     0.08
   13          U     16
   14          U1   0.0      160      590      813      655      418      260      155       92       61
   15          U1    40       26       15        7        3      0.0
   16          X              0.        1
   17          K      0       16                                          1
   18          K1     INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNIT HYDROGRAPH DAM 3
   19          M      1       -1     0.06             0.06      1.0
   20          P             25.6      100      120      130
   21          T                                                  1.00     0.08
   22          U      8
   23          U1   0.0        2      323      115       25        5        1      0.0
   24          X              0.        1
   25          K      2       16                                          1
   26          K1     COMBINE INFLOW HYDROGRAPHS FOR CEDAR HILL NUMBER 2 AND 3 DAMS
   27          K      1       16                        2                 1
   28          K1     ROUTE COMBINED INFLOW HYDROGRAPH THROUGH CEDAR HILL DAMS 2 AND 3 COMBINED
   29          Y                                1        1
   30          Y1     1                                                -540.       -1
   31          Y4   540.   541.45   542.84   543.50   544.20   544.87   545.00   545.53   546.74
   32          Y5   0.0       216      649      935     1270     1676     1761     3153     8890
   33          S$   0.0       0.9    247.5      308      338      460      780
   34          SE   506       507      540    543.5      545      550      560
   35          S$   540
   36          SD   545
   37          K    99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	15
RUNOFF HYDROGRAPH AT	16
COMBINE 2 HYDROGRAPHS AT	16
ROUTE HYDROGRAPH TO	16
END OF NETWORK	

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  21 AUG 78
**********************************

RUN  DATE= 78/11/30.
     TIME= 13.28.56.
```

DAM SAFETY INSPECTION - MISSOURI
CEDAR HILL LAKE NUMBER 2 AND 3 DAMS
PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING

JOB SPECIFICATION

NQ	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	0	0

JOPER	NRT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNI

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
15	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	.42	0.00	.42	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.60	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.08	0.00	0.00

GIVEN UNIT GRAPH, NUMGO= 16

0.	160.	590.	813.	655.	418.	260.	155.	92.	51.
30.	20.	15.	7.	3.	0.				

UNIT GRAPH TOTALS 3295. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

MO,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1,01	.05	1	.01	0.00	.01	0.	1,01	12.35	151	.21	.21	.01	884.

1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.21	.21	.01	686.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.21	.21	.01	690.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.01	688.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.21	.01	678.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.21	.01	677.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.26	.25	.01	680.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.26	.25	.01	687.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.26	.25	.01	713.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.26	.25	.01	748.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.25	161	.26	.25	.01	776.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.26	.25	.01	793.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.35	163	.26	.25	.01	805.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.40	164	.26	.25	.01	811.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.45	165	.26	.25	.01	815.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.50	166	.26	.25	.01	818.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.55	167	.26	.25	.01	819.
1.01	1.30	18	.01	0.00	.01	0.	1.01	14.00	168	.26	.25	.01	820.
1.01	1.35	19	.01	0.00	.01	0.	1.01	14.05	169	.32	.31	.01	821.
1.01	1.40	20	.01	0.00	.01	0.	1.01	14.10	170	.32	.31	.01	832.
1.01	1.45	21	.01	0.00	.01	0.	1.01	14.15	171	.32	.31	.01	870.
1.01	1.50	22	.01	0.00	.01	0.	1.01	14.20	172	.32	.31	.01	922.
1.01	1.55	23	.01	0.00	.01	0.	1.01	14.25	173	.32	.31	.01	964.
1.01	2.00	24	.01	0.00	.01	0.	1.01	14.30	174	.32	.31	.01	990.
1.01	2.05	25	.01	0.00	.01	0.	1.01	14.35	175	.32	.31	.01	1007.
1.01	2.10	26	.01	0.00	.01	0.	1.01	14.40	176	.32	.31	.01	1017.
1.01	2.15	27	.01	0.00	.01	0.	1.01	14.45	177	.32	.31	.01	1023.
1.01	2.20	28	.01	0.00	.01	0.	1.01	14.50	178	.32	.31	.01	1027.
1.01	2.25	29	.01	0.00	.01	0.	1.01	14.55	179	.32	.31	.01	1028.
1.01	2.30	30	.01	0.00	.01	0.	1.01	15.00	180	.32	.31	.01	1031.
1.01	2.35	31	.01	0.00	.01	0.	1.01	15.05	181	.19	.19	.01	1032.
1.01	2.40	32	.01	0.00	.01	0.	1.01	15.10	182	.39	.38	.01	1012.
1.01	2.45	33	.01	0.00	.01	0.	1.01	15.15	183	.39	.38	.01	969.
1.01	2.50	34	.01	0.00	.01	0.	1.01	15.20	184	.58	.58	.01	902.
1.01	2.55	35	.01	0.00	.01	0.	1.01	15.25	185	.68	.67	.01	1084.
1.01	3.00	36	.01	0.00	.01	0.	1.01	15.30	186	1.65	1.65	.01	1895.
1.01	3.05	37	.01	0.00	.01	0.	1.01	15.35	187	2.72	2.72	.01	1715.
1.01	3.10	38	.01	0.00	.01	0.	1.01	15.40	188	1.07	1.06	.01	2698.
1.01	3.15	39	.01	0.00	.01	0.	1.01	15.45	189	.68	.67	.01	4019.
1.01	3.20	40	.01	0.00	.01	0.	1.01	15.50	190	.58	.58	.01	4590.
1.01	3.25	41	.01	0.00	.01	0.	1.01	15.55	191	.39	.38	.01	4170.
1.01	3.30	42	.01	0.00	.01	0.	1.01	16.00	192	.39	.38	.01	3419.
1.01	3.35	43	.01	0.00	.01	0.	1.01	16.05	193	.30	.29	.01	2732.
1.01	3.40	44	.01	0.00	.01	0.	1.01	16.10	194	.30	.29	.01	2174.
1.01	3.45	45	.01	0.00	.01	0.	1.01	16.15	195	.30	.29	.01	1763.
1.01	3.50	46	.01	0.00	.01	0.	1.01	16.20	196	.30	.29	.01	1481.
1.01	3.55	47	.01	0.00	.01	0.	1.01	16.25	197	.30	.29	.01	1290.
1.01	4.00	48	.01	0.00	.01	0.	1.01	16.30	198	.30	.29	.01	1167.
1.01	4.05	49	.01	0.00	.01	0.	1.01	16.35	199	.30	.29	.01	1084.
1.01	4.10	50	.01	0.00	.01	0.	1.01	16.40	200	.30	.29	.01	1038.
1.01	4.15	51	.01	0.00	.01	0.	1.01	16.45	201	.30	.29	.01	997.
1.01	4.20	52	.01	0.00	.01	0.	1.01	16.50	202	.30	.29	.01	977.
1.01	4.25	53	.01	0.00	.01	0.	1.01	16.55	203	.30	.29	.01	969.
1.01	4.30	54	.01	0.00	.01	0.	1.01	17.00	204	.30	.29	.01	965.
1.01	4.35	55	.01	0.00	.01	0.	1.01	17.05	205	.23	.23	.01	963.
1.01	4.40	56	.01	0.00	.01	0.	1.01	17.10	206	.23	.23	.01	952.
1.01	4.45	57	.01	0.00	.01	0.	1.01	17.15	207	.23	.23	.01	916.
1.01	4.50	58	.01	0.00	.01	0.	1.01	17.20	208	.23	.23	.01	862.
1.01	4.55	59	.01	0.00	.01	0.	1.01	17.25	209	.23	.23	.01	820.
1.01	5.00	60	.01	0.00	.01	0.	1.01	17.30	210	.23	.23	.01	793.
1.01	5.05	61	.01	0.00	.01	0.	1.01	17.35	211	.23	.23	.01	777.

1.01	5.10	62	.01	0.00	.01	0.
1.01	5.15	63	.01	0.00	.01	0.
1.01	5.20	64	.01	0.00	.01	0.
1.01	5.25	65	.01	0.00	.01	0.
1.01	5.30	66	.01	0.00	.01	0.
1.01	5.35	67	.01	0.00	.01	0.
1.01	5.40	68	.01	0.00	.01	0.
1.01	5.45	69	.01	0.00	.01	0.
1.01	5.50	70	.01	0.00	.01	0.
1.01	5.55	71	.01	.01	.01	0.
1.01	6.00	72	.01	.01	.01	1.
1.01	6.05	73	.07	.06	.01	4.
1.01	6.10	74	.07	.06	.01	19.
1.01	6.15	75	.07	.06	.01	58.
1.01	6.20	76	.07	.06	.01	104.
1.01	6.25	77	.07	.06	.01	147.
1.01	6.30	78	.07	.06	.01	173.
1.01	6.35	79	.07	.06	.01	188.
1.01	6.40	80	.07	.06	.01	198.
1.01	6.45	81	.07	.06	.01	203.
1.01	6.50	82	.07	.06	.01	207.
1.01	6.55	83	.07	.06	.01	209.
1.01	7.00	84	.07	.06	.01	211.
1.01	7.05	85	.07	.06	.01	212.
1.01	7.10	86	.07	.06	.01	212.
1.01	7.15	87	.07	.06	.01	212.
1.01	7.20	88	.07	.06	.01	212.
1.01	7.25	89	.07	.06	.01	212.
1.01	7.30	90	.07	.06	.01	212.
1.01	7.35	91	.07	.06	.01	212.
1.01	7.40	92	.07	.06	.01	212.
1.01	7.45	93	.07	.06	.01	212.
1.01	7.50	94	.07	.06	.01	212.
1.01	7.55	95	.07	.06	.01	212.
1.01	8.00	96	.07	.06	.01	212.
1.01	8.05	97	.07	.06	.01	212.
1.01	8.10	98	.07	.06	.01	212.
1.01	8.15	99	.07	.06	.01	212.
1.01	8.20	100	.07	.06	.01	212.
1.01	8.25	101	.07	.06	.01	212.
1.01	8.30	102	.07	.06	.01	212.
1.01	8.35	103	.07	.06	.01	212.
1.01	8.40	104	.07	.06	.01	212.
1.01	8.45	105	.07	.06	.01	212.
1.01	8.50	106	.07	.06	.01	212.
1.01	8.55	107	.07	.06	.01	212.
1.01	9.00	108	.07	.06	.01	212.
1.01	9.05	109	.07	.06	.01	212.
1.01	9.10	110	.07	.06	.01	212.
1.01	9.15	111	.07	.06	.01	212.
1.01	9.20	112	.07	.06	.01	212.
1.01	9.25	113	.07	.06	.01	212.
1.01	9.30	114	.07	.06	.01	212.
1.01	9.35	115	.07	.06	.01	212.
1.01	9.40	116	.07	.06	.01	212.
1.01	9.45	117	.07	.06	.01	212.
1.01	9.50	118	.07	.06	.01	212.
1.01	9.55	119	.07	.06	.01	212.
1.01	10.00	120	.07	.06	.01	212.
1.01	10.05	121	.07	.06	.01	212.

1.01	17.40	212	.23	.23	.01	767.
1.01	17.45	213	.23	.23	.01	761.
1.01	17.50	214	.23	.23	.01	757.
1.01	17.55	215	.23	.23	.01	755.
1.01	18.00	216	.23	.23	.01	753.
1.01	18.05	217	.02	.01	.01	752.
1.01	18.10	218	.02	.01	.01	717.
1.01	18.15	219	.02	.01	.01	591.
1.01	18.20	220	.02	.01	.01	418.
1.01	18.25	221	.02	.01	.01	278.
1.01	18.30	222	.02	.01	.01	189.
1.01	18.35	223	.02	.01	.01	133.
1.01	18.40	224	.02	.01	.01	100.
1.01	18.45	225	.02	.01	.01	81.
1.01	18.50	226	.02	.01	.01	68.
1.01	18.55	227	.02	.01	.01	59.
1.01	19.00	228	.02	.01	.01	54.
1.01	19.05	229	.02	.01	.01	50.
1.01	19.10	230	.02	.01	.01	49.
1.01	19.15	231	.02	.01	.01	48.
1.01	19.20	232	.02	.01	.01	48.
1.01	19.25	233	.02	.01	.01	48.
1.01	19.30	234	.02	.01	.01	48.
1.01	19.35	235	.02	.01	.01	48.
1.01	19.40	236	.02	.01	.01	48.
1.01	19.45	237	.02	.01	.01	48.
1.01	19.50	238	.02	.01	.01	48.
1.01	19.55	239	.02	.01	.01	48.
1.01	20.00	240	.02	.01	.01	48.
1.01	20.05	241	.02	.01	.01	48.
1.01	20.10	242	.02	.01	.01	48.
1.01	20.15	243	.02	.01	.01	48.
1.01	20.20	244	.02	.01	.01	48.
1.01	20.25	245	.02	.01	.01	48.
1.01	20.30	246	.02	.01	.01	48.
1.01	20.35	247	.02	.01	.01	48.
1.01	20.40	248	.02	.01	.01	48.
1.01	20.45	249	.02	.01	.01	48.
1.01	20.50	250	.02	.01	.01	48.
1.01	20.55	251	.02	.01	.01	48.
1.01	21.00	252	.02	.01	.01	48.
1.01	21.05	253	.02	.01	.01	48.
1.01	21.10	254	.02	.01	.01	48.
1.01	21.15	255	.02	.01	.01	48.
1.01	21.20	256	.02	.01	.01	48.
1.01	21.25	257	.02	.01	.01	48.
1.01	21.30	258	.02	.01	.01	48.
1.01	21.35	259	.02	.01	.01	48.
1.01	21.40	260	.02	.01	.01	48.
1.01	21.45	261	.02	.01	.01	48.
1.01	21.50	262	.02	.01	.01	48.
1.01	21.55	263	.02	.01	.01	48.
1.01	22.00	264	.02	.01	.01	48.
1.01	22.05	265	.02	.01	.01	48.
1.01	22.10	266	.02	.01	.01	48.
1.01	22.15	267	.02	.01	.01	48.
1.01	22.20	268	.02	.01	.01	48.
1.01	22.25	269	.02	.01	.01	48.
1.01	22.30	270	.02	.01	.01	48.
1.01	22.35	271	.02	.01	.01	48.

1,01	10,10	122	,07	,06	,01	212,	1,01	22,40	272	,02	,01	,01	48,
1,01	10,15	123	,07	,06	,01	212,	1,01	22,45	273	,02	,01	,01	48,
1,01	10,20	124	,07	,06	,01	212,	1,01	22,50	274	,02	,01	,01	48,
1,01	10,25	125	,07	,06	,01	212,	1,01	22,55	275	,02	,01	,01	48,
1,01	10,30	126	,07	,06	,01	212,	1,01	23,00	276	,02	,01	,01	48,
1,01	10,35	127	,07	,06	,01	212,	1,01	23,05	277	,02	,01	,01	48,
1,01	10,40	128	,07	,06	,01	212,	1,01	23,10	278	,02	,01	,01	48,
1,01	10,45	129	,07	,06	,01	212,	1,01	23,15	279	,02	,01	,01	48,
1,01	10,50	130	,07	,06	,01	212,	1,01	23,20	280	,02	,01	,01	48,
1,01	10,55	131	,07	,06	,01	212,	1,01	23,25	281	,02	,01	,01	48,
1,01	11,00	132	,07	,06	,01	212,	1,01	23,30	282	,02	,01	,01	48,
1,01	11,05	133	,07	,06	,01	212,	1,01	23,35	283	,02	,01	,01	48,
1,01	11,10	134	,07	,06	,01	212,	1,01	23,40	284	,02	,01	,01	48,
1,01	11,15	135	,07	,06	,01	212,	1,01	23,45	285	,02	,01	,01	48,
1,01	11,20	136	,07	,06	,01	212,	1,01	23,50	286	,02	,01	,01	48,
1,01	11,25	137	,07	,06	,01	212,	1,01	23,55	287	,02	,01	,01	48,
1,01	11,30	138	,07	,06	,01	212,	1,02	0,00	288	,02	,01	,01	48,
1,01	11,35	139	,07	,06	,01	212,	1,02	,05	289	0,00	0,00	0,00	48,
1,01	11,40	140	,07	,06	,01	212,	1,02	,10	290	0,00	0,00	0,00	46,
1,01	11,45	141	,07	,06	,01	212,	1,02	,15	291	0,00	0,00	0,00	37,
1,01	11,50	142	,07	,06	,01	212,	1,02	,20	292	0,00	0,00	0,00	25,
1,01	11,55	143	,07	,06	,01	212,	1,02	,25	293	0,00	0,00	0,00	16,
1,01	12,00	144	,07	,06	,01	212,	1,02	,30	294	0,00	0,00	0,00	10,
1,01	12,05	145	,21	,21	,01	212,	1,02	,35	295	0,00	0,00	0,00	6,
1,01	12,10	146	,21	,21	,01	235,	1,02	,40	296	0,00	0,00	0,00	4,
1,01	12,15	147	,21	,21	,01	319,	1,02	,45	297	0,00	0,00	0,00	2,
1,01	12,20	148	,21	,21	,01	435,	1,02	,50	298	0,00	0,00	0,00	1,
1,01	12,25	149	,21	,21	,01	528,	1,02	,55	299	0,00	0,00	0,00	1,
1,01	12,30	150	,21	,21	,01	587,	1,02	1,00	300	0,00	0,00	0,00	0,
									SUM	33,28	30,83	2,45	101540,
										(845,)(	783,)(	62,)(	2875,29)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4590,	1137,	353,	339,	101580,
CMS	130,	32,	10,	10,	2876,
INCHES		25,18	31,25	31,25	31,25
MM		639,61	793,69	793,69	793,69
AC-FT		564,	700,	700,	700,
THOUS CU M		695,	863,	863,	863,

HYDROGRAPH AT STA IS FOR PLAN 1, RTIO 1

0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0,	1,	4,	19,	58,	108,	147,	173,	188,	198,
203,	207,	209,	211,	212,	212,	212,	212,	212,	212,
212,	212,	212,	212,	212,	212,	212,	212,	212,	212,
212,	212,	212,	212,	212,	212,	212,	212,	212,	212,
212,	212,	212,	212,	212,	212,	212,	212,	212,	212,
212,	212,	212,	212,	212,	212,	212,	212,	212,	212,
212,	212,	212,	212,	212,	235,	319,	435,	528,	587,
629,	646,	659,	668,	674,	677,	680,	687,	713,	740,

776.	793.	805.	811.	815.	818.	819.	820.	821.	832.
870.	922.	964.	980.	1007.	1017.	1023.	1027.	1029.	1931.
1032.	1012.	969.	982.	1089.	1295.	1715.	2698.	4019.	4590.
4170.	3419.	2732.	2174.	1763.	1481.	1290.	1167.	1084.	1030.
997.	977.	969.	965.	963.	952.	914.	862.	820.	793.
777.	767.	761.	757.	755.	753.	752.	717.	591.	418.
278.	189.	133.	100.	81.	68.	59.	54.	50.	49.
48.	48.	48.	48.	48.	48.	48.	48.	48.	48.
48.	48.	48.	48.	48.	48.	48.	48.	48.	48.
48.	48.	48.	48.	48.	48.	48.	48.	48.	48.
48.	48.	48.	48.	48.	48.	48.	48.	48.	48.
48.	48.	48.	48.	48.	48.	48.	48.	48.	48.
48.	48.	48.	48.	48.	48.	48.	48.	48.	46.
37.	25.	16.	10.	6.	4.	2.	1.	1.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4590.	1137.	353.	339.	101580.
CMS	130.	32.	10.	10.	2876.
INCHES		25.18	31.25	31.25	31.25
MM		639.61	793.69	793.69	793.69
AC-FT		564.	700.	700.	700.
THOUS CU M		695.	863.	863.	863.

HYDROGRAPH AT STA 15 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	2.	9.	29.	54.	74.	86.	94.	99.
102.	103.	105.	105.	106.	106.	106.	106.	106.	106.
106.	106.	106.	106.	106.	106.	106.	106.	106.	106.
106.	106.	106.	106.	106.	106.	106.	106.	106.	106.
106.	106.	106.	106.	106.	106.	106.	106.	106.	106.
106.	106.	106.	106.	106.	106.	106.	106.	106.	106.
106.	106.	106.	106.	106.	106.	106.	106.	106.	106.
106.	106.	106.	106.	106.	118.	160.	217.	264.	294.
312.	323.	330.	330.	337.	339.	340.	344.	356.	374.
388.	397.	402.	406.	408.	409.	410.	410.	411.	416.
435.	461.	482.	495.	503.	508.	511.	513.	515.	515.
516.	506.	485.	491.	545.	647.	857.	1349.	2009.	2295.
2085.	1710.	1366.	1087.	882.	740.	645.	583.	542.	515.
499.	489.	484.	482.	482.	476.	457.	431.	410.	397.
388.	383.	380.	379.	377.	376.	376.	359.	296.	209.
139.	84.	67.	50.	40.	34.	30.	27.	25.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	23.
19.	13.	8.	5.	3.	2.	1.	1.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2295.	568.	176.	169.	50790.
CMS	65.	16.	5.	5.	1438.

INCHES	12.59	15.62	15.62	15.62
MM	319.81	396.85	396.85	396.85
AC-FT	282.	350.	350.	350.
THOUS CU M	348.	431.	431.	431.

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNI

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
16	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISAME	LOCAL
1	1	.06	0.00	.06	1.00	0.000	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.60	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.08	0.00	0.00

GIVEN UNIT GRAPH, NUMGU= 8

0.	2.	323.	115.	25.	5.	1.	0.

UNIT GRAPH TOTALS 471. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.35	151	.21	.21	.01	97.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.21	.21	.01	97.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.21	.21	.01	97.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.01	97.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.21	.01	97.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.21	.01	97.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.26	.25	.01	97.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.26	.25	.01	97.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.26	.25	.01	111.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.26	.25	.01	116.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.25	161	.26	.25	.01	117.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.26	.25	.01	117.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.35	163	.26	.25	.01	117.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.40	164	.26	.25	.01	117.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.45	165	.26	.25	.01	117.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.50	166	.26	.25	.01	117.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.55	167	.26	.25	.01	117.
1.01	1.30	18	.01	0.00	.01	0.	1.01	14.00	168	.26	.25	.01	117.
1.01	1.35	19	.01	0.00	.01	0.	1.01	14.05	169	.32	.31	.01	117.
1.01	1.40	20	.01	0.00	.01	0.	1.01	14.10	170	.32	.31	.01	118.
1.01	1.45	21	.01	0.00	.01	0.	1.01	14.15	171	.32	.31	.01	138.

AD-A104 782 PRC CONSOER TOWNSEND INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. CEDAR HILL LAKE NUMBER 2 AND NUMBE--ETC(U)
JAN 79 W G SHIFRIN DACW43-78-C-0160
UNCLASSIFIED NL

END
DATE FILMED
10-81
DTIC

1.01	1.50	22	.01	0.00	.01	0.
1.01	1.55	23	.01	0.00	.01	0.
1.01	2.00	24	.01	0.00	.01	0.
1.01	2.05	25	.01	0.00	.01	0.
1.01	2.10	26	.01	0.00	.01	0.
1.01	2.15	27	.01	0.00	.01	0.
1.01	2.20	28	.01	0.00	.01	0.
1.01	2.25	29	.01	0.00	.01	0.
1.01	2.30	30	.01	0.00	.01	0.
1.01	2.35	31	.01	0.00	.01	0.
1.01	2.40	32	.01	0.00	.01	0.
1.01	2.45	33	.01	0.00	.01	0.
1.01	2.50	34	.01	0.00	.01	0.
1.01	2.55	35	.01	0.00	.01	0.
1.01	3.00	36	.01	0.00	.01	0.
1.01	3.05	37	.01	0.00	.01	0.
1.01	3.10	38	.01	0.00	.01	0.
1.01	3.15	39	.01	0.00	.01	0.
1.01	3.20	40	.01	0.00	.01	0.
1.01	3.25	41	.01	0.00	.01	0.
1.01	3.30	42	.01	0.00	.01	0.
1.01	3.35	43	.01	0.00	.01	0.
1.01	3.40	44	.01	0.00	.01	0.
1.01	3.45	45	.01	0.00	.01	0.
1.01	3.50	46	.01	0.00	.01	0.
1.01	3.55	47	.01	0.00	.01	0.
1.01	4.00	48	.01	0.00	.01	0.
1.01	4.05	49	.01	0.00	.01	0.
1.01	4.10	50	.01	0.00	.01	0.
1.01	4.15	51	.01	0.00	.01	0.
1.01	4.20	52	.01	0.00	.01	0.
1.01	4.25	53	.01	0.00	.01	0.
1.01	4.30	54	.01	0.00	.01	0.
1.01	4.35	55	.01	0.00	.01	0.
1.01	4.40	56	.01	0.00	.01	0.
1.01	4.45	57	.01	0.00	.01	0.
1.01	4.50	58	.01	0.00	.01	0.
1.01	4.55	59	.01	0.00	.01	0.
1.01	5.00	60	.01	0.00	.01	0.
1.01	5.05	61	.01	0.00	.01	0.
1.01	5.10	62	.01	0.00	.01	0.
1.01	5.15	63	.01	0.00	.01	0.
1.01	5.20	64	.01	0.00	.01	0.
1.01	5.25	65	.01	0.00	.01	0.
1.01	5.30	66	.01	0.00	.01	0.
1.01	5.35	67	.01	0.00	.01	0.
1.01	5.40	68	.01	0.00	.01	0.
1.01	5.45	69	.01	0.00	.01	0.
1.01	5.50	70	.01	0.00	.01	0.
1.01	5.55	71	.01	.01	.01	0.
1.01	6.00	72	.01	.01	.01	0.
1.01	6.05	73	.07	.06	.01	2.
1.01	6.10	74	.07	.06	.01	3.
1.01	6.15	75	.07	.06	.01	22.
1.01	6.20	76	.07	.06	.01	29.
1.01	6.25	77	.07	.06	.01	30.
1.01	6.30	78	.07	.06	.01	30.
1.01	6.35	79	.07	.06	.01	30.
1.01	6.40	80	.07	.06	.01	30.
1.01	6.45	81	.07	.06	.01	30.

1.01	14.20	172	.32	.31	.01	146.
1.01	14.25	173	.32	.31	.01	147.
1.01	14.30	174	.32	.31	.01	148.
1.01	14.35	175	.32	.31	.01	148.
1.01	14.40	176	.32	.31	.01	148.
1.01	14.45	177	.32	.31	.01	148.
1.01	14.50	178	.32	.31	.01	148.
1.01	14.55	179	.32	.31	.01	148.
1.01	15.00	180	.32	.31	.01	148.
1.01	15.05	181	.19	.19	.01	148.
1.01	15.10	182	.39	.38	.01	147.
1.01	15.15	183	.39	.38	.01	107.
1.01	15.20	184	.58	.58	.01	156.
1.01	15.25	185	.68	.67	.01	175.
1.01	15.30	186	1.65	1.65	.01	283.
1.01	15.35	187	2.72	2.72	.01	299.
1.01	15.40	188	1.07	1.06	.01	632.
1.01	15.45	189	.68	.67	.01	1089.
1.01	15.50	190	.58	.58	.01	702.
1.01	15.55	191	.39	.38	.01	418.
1.01	16.00	192	.39	.38	.01	307.
1.01	16.05	193	.30	.29	.01	216.
1.01	16.10	194	.30	.29	.01	187.
1.01	16.15	195	.30	.29	.01	152.
1.01	16.20	196	.30	.29	.01	141.
1.01	16.25	197	.30	.29	.01	138.
1.01	16.30	198	.30	.29	.01	138.
1.01	16.35	199	.30	.29	.01	138.
1.01	16.40	200	.30	.29	.01	138.
1.01	16.45	201	.30	.29	.01	138.
1.01	16.50	202	.30	.29	.01	138.
1.01	16.55	203	.30	.29	.01	138.
1.01	17.00	204	.30	.29	.01	138.
1.01	17.05	205	.23	.23	.01	138.
1.01	17.10	206	.23	.23	.01	137.
1.01	17.15	207	.23	.23	.01	117.
1.01	17.20	208	.23	.23	.01	109.
1.01	17.25	209	.23	.23	.01	108.
1.01	17.30	210	.23	.23	.01	107.
1.01	17.35	211	.23	.23	.01	107.
1.01	17.40	212	.23	.23	.01	107.
1.01	17.45	213	.23	.23	.01	107.
1.01	17.50	214	.23	.23	.01	107.
1.01	17.55	215	.23	.23	.01	107.
1.01	18.00	216	.23	.23	.01	107.
1.01	18.05	217	.02	.01	.01	107.
1.01	18.10	218	.02	.01	.01	107.
1.01	18.15	219	.02	.01	.01	38.
1.01	18.20	220	.02	.01	.01	14.
1.01	18.25	221	.02	.01	.01	8.
1.01	18.30	222	.02	.01	.01	7.
1.01	18.35	223	.02	.01	.01	7.
1.01	18.40	224	.02	.01	.01	7.
1.01	18.45	225	.02	.01	.01	7.
1.01	18.50	226	.02	.01	.01	7.
1.01	18.55	227	.02	.01	.01	7.
1.01	19.00	228	.02	.01	.01	7.
1.01	19.05	229	.02	.01	.01	7.
1.01	19.10	230	.02	.01	.01	7.
1.01	19.15	231	.02	.01	.01	7.

1.01	6.50	82	.07	.06	.01	30.	1.01	19.20	232	.02	.01	.01	7.
1.01	6.55	83	.07	.06	.01	30.	1.01	19.25	233	.02	.01	.01	7.
1.01	7.00	84	.07	.06	.01	30.	1.01	19.30	234	.02	.01	.01	7.
1.01	7.05	85	.07	.06	.01	30.	1.01	19.35	235	.02	.01	.01	7.
1.01	7.10	86	.07	.06	.01	30.	1.01	19.40	236	.02	.01	.01	7.
1.01	7.15	87	.07	.06	.01	30.	1.01	19.45	237	.02	.01	.01	7.
1.01	7.20	88	.07	.06	.01	30.	1.01	19.50	238	.02	.01	.01	7.
1.01	7.25	89	.07	.06	.01	30.	1.01	19.55	239	.02	.01	.01	7.
1.01	7.30	90	.07	.06	.01	30.	1.01	20.00	240	.02	.01	.01	7.
1.01	7.35	91	.07	.06	.01	30.	1.01	20.05	241	.02	.01	.01	7.
1.01	7.40	92	.07	.06	.01	30.	1.01	20.10	242	.02	.01	.01	7.
1.01	7.45	93	.07	.06	.01	30.	1.01	20.15	243	.02	.01	.01	7.
1.01	7.50	94	.07	.06	.01	30.	1.01	20.20	244	.02	.01	.01	7.
1.01	7.55	95	.07	.06	.01	30.	1.01	20.25	245	.02	.01	.01	7.
1.01	8.00	96	.07	.06	.01	30.	1.01	20.30	246	.02	.01	.01	7.
1.01	8.05	97	.07	.06	.01	30.	1.01	20.35	247	.02	.01	.01	7.
1.01	8.10	98	.07	.06	.01	30.	1.01	20.40	248	.02	.01	.01	7.
1.01	8.15	99	.07	.06	.01	30.	1.01	20.45	249	.02	.01	.01	7.
1.01	8.20	100	.07	.06	.01	30.	1.01	20.50	250	.02	.01	.01	7.
1.01	8.25	101	.07	.06	.01	30.	1.01	20.55	251	.02	.01	.01	7.
1.01	8.30	102	.07	.06	.01	30.	1.01	21.00	252	.02	.01	.01	7.
1.01	8.35	103	.07	.06	.01	30.	1.01	21.05	253	.02	.01	.01	7.
1.01	8.40	104	.07	.06	.01	30.	1.01	21.10	254	.02	.01	.01	7.
1.01	8.45	105	.07	.06	.01	30.	1.01	21.15	255	.02	.01	.01	7.
1.01	8.50	106	.07	.06	.01	30.	1.01	21.20	256	.02	.01	.01	7.
1.01	8.55	107	.07	.06	.01	30.	1.01	21.25	257	.02	.01	.01	7.
1.01	9.00	108	.07	.06	.01	30.	1.01	21.30	258	.02	.01	.01	7.
1.01	9.05	109	.07	.06	.01	30.	1.01	21.35	259	.02	.01	.01	7.
1.01	9.10	110	.07	.06	.01	30.	1.01	21.40	260	.02	.01	.01	7.
1.01	9.15	111	.07	.06	.01	30.	1.01	21.45	261	.02	.01	.01	7.
1.01	9.20	112	.07	.06	.01	30.	1.01	21.50	262	.02	.01	.01	7.
1.01	9.25	113	.07	.06	.01	30.	1.01	21.55	263	.02	.01	.01	7.
1.01	9.30	114	.07	.06	.01	30.	1.01	22.00	264	.02	.01	.01	7.
1.01	9.35	115	.07	.06	.01	30.	1.01	22.05	265	.02	.01	.01	7.
1.01	9.40	116	.07	.06	.01	30.	1.01	22.10	266	.02	.01	.01	7.
1.01	9.45	117	.07	.06	.01	30.	1.01	22.15	267	.02	.01	.01	7.
1.01	9.50	118	.07	.06	.01	30.	1.01	22.20	268	.02	.01	.01	7.
1.01	9.55	119	.07	.06	.01	30.	1.01	22.25	269	.02	.01	.01	7.
1.01	10.00	120	.07	.06	.01	30.	1.01	22.30	270	.02	.01	.01	7.
1.01	10.05	121	.07	.06	.01	30.	1.01	22.35	271	.02	.01	.01	7.
1.01	10.10	122	.07	.06	.01	30.	1.01	22.40	272	.02	.01	.01	7.
1.01	10.15	123	.07	.06	.01	30.	1.01	22.45	273	.02	.01	.01	7.
1.01	10.20	124	.07	.06	.01	30.	1.01	22.50	274	.02	.01	.01	7.
1.01	10.25	125	.07	.06	.01	30.	1.01	22.55	275	.02	.01	.01	7.
1.01	10.30	126	.07	.06	.01	30.	1.01	23.00	276	.02	.01	.01	7.
1.01	10.35	127	.07	.06	.01	30.	1.01	23.05	277	.02	.01	.01	7.
1.01	10.40	128	.07	.06	.01	30.	1.01	23.10	278	.02	.01	.01	7.
1.01	10.45	129	.07	.06	.01	30.	1.01	23.15	279	.02	.01	.01	7.
1.01	10.50	130	.07	.06	.01	30.	1.01	23.20	280	.02	.01	.01	7.
1.01	10.55	131	.07	.06	.01	30.	1.01	23.25	281	.02	.01	.01	7.
1.01	11.00	132	.07	.06	.01	30.	1.01	23.30	282	.02	.01	.01	7.
1.01	11.05	133	.07	.06	.01	30.	1.01	23.35	283	.02	.01	.01	7.
1.01	11.10	134	.07	.06	.01	30.	1.01	23.40	284	.02	.01	.01	7.
1.01	11.15	135	.07	.06	.01	30.	1.01	23.45	285	.02	.01	.01	7.
1.01	11.20	136	.07	.06	.01	30.	1.01	23.50	286	.02	.01	.01	7.
1.01	11.25	137	.07	.06	.01	30.	1.01	23.55	287	.02	.01	.01	7.
1.01	11.30	138	.07	.06	.01	30.	1.02	0.00	288	.02	.01	.01	7.
1.01	11.35	139	.07	.06	.01	30.	1.02	.05	289	0.00	0.00	0.00	7.
1.01	11.40	140	.07	.06	.01	30.	1.02	.10	290	0.00	0.00	0.00	7.
1.01	11.45	141	.07	.06	.01	30.	1.02	.15	291	0.00	0.00	0.00	7.

1.01	11.50	142	.07	.06	.01	30.	1.02	.20	292	0.00	0.00	0.00	0.
1.01	11.55	143	.07	.06	.01	30.	1.02	.25	293	0.00	0.00	0.00	0.
1.01	12.00	144	.07	.06	.01	30.	1.02	.30	294	0.00	0.00	0.00	0.
1.01	12.05	145	.21	.21	.01	30.	1.02	.35	295	0.00	0.00	0.00	0.
1.01	12.10	146	.21	.21	.01	31.	1.02	.40	296	0.00	0.00	0.00	0.
1.01	12.15	147	.21	.21	.01	77.	1.02	.45	297	0.00	0.00	0.00	0.
1.01	12.20	148	.21	.21	.01	93.	1.02	.50	298	0.00	0.00	0.00	0.
1.01	12.25	149	.21	.21	.01	96.	1.02	.55	299	0.00	0.00	0.00	0.
1.01	12.30	150	.21	.21	.01	97.	1.02	1.00	300	0.00	0.00	0.00	0.
									SUM	33.28	30.83	2.45	14501.
										(845.)(	783.)(	62.)(	410.62)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1089.	164.	50.	48.	14520.
CMS	31.	5.	1.	1.	411.
INCHES		25.57	31.27	31.27	31.27
MM		648.80	794.18	794.18	794.18
AC-FT		81.	100.	100.	100.
THOUS CU M		100.	123.	123.	123.

HYDROGRAPH AT STA 16 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	2.	3.	22.	29.	30.	30.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	30.	31.	77.	93.	96.	97.
97.	97.	97.	97.	97.	97.	97.	97.	111.	116.
117.	117.	117.	117.	117.	117.	117.	117.	117.	118.
138.	136.	147.	148.	148.	148.	148.	148.	148.	148.
148.	147.	107.	154.	175.	243.	299.	632.	1089.	702.
418.	307.	216.	187.	152.	141.	138.	138.	138.	138.
138.	138.	138.	138.	138.	137.	117.	109.	108.	107.
107.	107.	107.	107.	107.	107.	107.	107.	38.	18.
8.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
2.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1089.	164.	50.	48.	14520.
CMS	31.	5.	1.	1.	411.
INCHES		25.57	31.27	31.27	31.27
MM		648.80	794.18	794.18	794.18

AC-FT	81.	100.	100.		100.
THOUS CU M	100.	123.	123.		123.

HYDROGRAPH AT STA 16 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	1.	2.	11.	14.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	38.	46.	48.	49.
49.	49.	49.	49.	49.	49.	49.	49.	56.	58.
59.	59.	59.	59.	59.	59.	59.	59.	59.	59.
69.	73.	74.	74.	74.	74.	74.	74.	74.	74.
74.	74.	54.	78.	88.	121.	150.	316.	545.	351.
209.	153.	108.	93.	76.	70.	69.	69.	69.	69.
69.	69.	69.	69.	69.	69.	58.	55.	54.	54.
54.	54.	54.	54.	54.	54.	54.	53.	19.	7.
4.	4.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	545.	82.	25.	24.	7260.
CMS	15.	2.	1.	1.	206.
INCHES		12.68	15.63	15.63	15.63
MM		322.20	397.09	397.09	397.09
AC-FT		41.	50.	50.	50.
THOUS CU M		50.	62.	62.	62.

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COMBINE HYDROGRAPHS

COMBINE INFLOW HYDROGRAPHS FOR CEDAR HILL NUMBER 2 AND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
16	2	0	0	0	0	1	0	0

SUM OF 2 HYDROGRAPHS AT 16 PLAN 1 RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	1.	6.	22.	80.	134.	177.	203.	219.	228.
234.	237.	240.	241.	242.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	266.	396.	528.	624.	684.
722.	744.	757.	765.	771.	775.	777.	785.	824.	864.
893.	911.	922.	929.	933.	935.	937.	938.	939.	949.
1008.	1067.	1111.	1138.	1154.	1164.	1170.	1174.	1177.	1178.
1179.	1160.	1077.	1138.	1265.	1537.	2014.	3329.	5108.	5292.
4588.	3726.	2948.	2361.	1915.	1621.	1428.	1305.	1222.	1167.
1135.	1115.	1107.	1103.	1101.	1090.	1031.	971.	928.	901.
884.	874.	868.	864.	862.	860.	859.	824.	629.	431.
286.	196.	140.	107.	88.	75.	66.	61.	57.	56.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	53.
39.	26.	16.	10.	6.	4.	2.	1.	1.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5292.	1300.	403.	387.	116101.
CMS	150.	37.	11.	11.	3288.
INCHES		25.19	31.25	31.25	31.25
MM		639.81	793.75	793.75	793.75
AC-FT		645.	800.	800.	800.
THOUS CU M		795.	986.	986.	986.

SUM OF 2 HYDROGRAPHS AT 16 PLAN 1 RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	3.	11.	40.	68.	89.	101.	109.	114.
117.	119.	120.	121.	121.	121.	121.	121.	121.	121.
121.	121.	121.	121.	121.	121.	121.	121.	121.	121.
121.	121.	121.	121.	121.	121.	121.	121.	121.	121.
121.	121.	121.	121.	121.	121.	121.	121.	121.	121.
121.	121.	121.	121.	121.	121.	121.	121.	121.	121.
121.	121.	121.	121.	121.	121.	121.	121.	121.	121.
121.	121.	121.	121.	121.	133.	198.	268.	312.	342.
361.	372.	378.	383.	386.	387.	388.	392.	412.	432.
446.	455.	461.	464.	466.	468.	468.	469.	469.	475.
504.	534.	555.	569.	577.	582.	585.	587.	588.	589.

590.	580.	538.	969.	632.	769.	1007.	1665.	2554.	2486.
2294.	1863.	1474.	1181.	958.	811.	718.	652.	611.	584.
567.	557.	553.	551.	550.	545.	515.	486.	464.	450.
442.	437.	434.	432.	431.	430.	430.	412.	315.	216.
143.	98.	70.	53.	44.	37.	33.	30.	29.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	26.
20.	13.	8.	5.	3.	2.	1.	1.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2294.	650.	202.	194.	58050.
CMS	75.	18.	6.	5.	1644.
INCHES		12.59	15.63	15.63	15.63
MM		319.90	396.88	396.88	396.88
AC-FT		322.	400.	400.	400.
THOUS CU M		397.	493.	493.	493.

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HYDROGRAPH ROUTING

ROUTE COMBINED INFLOW HYDROGRAPH THROUGH CEDAR HILL DAM

ISTAO	ICOMP	ICOMB	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
16	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-580.	-1

STAGE	540.0	541.5	542.8	543.5	544.2	544.9	545.0	545.5	546.7
FLOW	0.	216.	649.	935.	1270.	1676.	1761.	3153.	8890.
CAPACITY=	0.	1.	248.	308.	338.	460.	780.		
ELEVATION=	506.	507.	540.	544.	545.	550.	560.		

CREL	SPWID	COOK	EXPW	ELEVL	COOL	CAREA	EXPL
540.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
545.0	0.0	0.0	0.

STATION 16, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW									
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

AND

DAM SAFETY ANALYSIS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

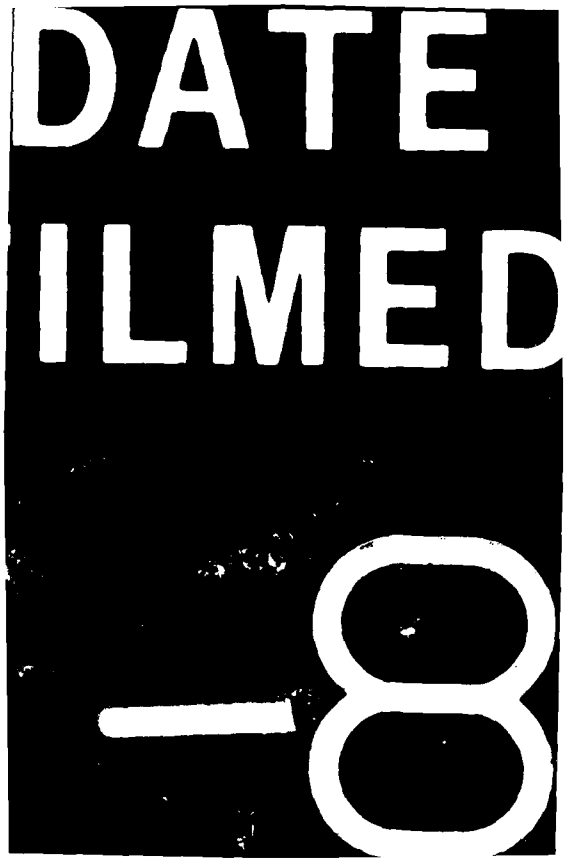
OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS	
				RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	15	.42	1	4590.	2295.
	(	1.09)	(	129.96)(	64.98)(
HYDROGRAPH AT	16	.06	1	1098.	545.
	(	.16)	(	31.09)(	15.42)(
2 COMBINED	16	.48	1	5292.	2616.
	(	1.24)	(	149.85)(	74.03)(
ROUTED TO	16	.48	1	4897.	1558.
	(	1.24)	(	138.67)(	44.12)(

MARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	540.00	540.00	545.00
STORAGE	248.	248.	358.
OUTFLOW	0.	0.	1761.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	545.77	.77	357.	3807.	.75	15.92	0.00
.50	544.88	.[illegible]	332.	1558.	0.00	16.08	0.00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